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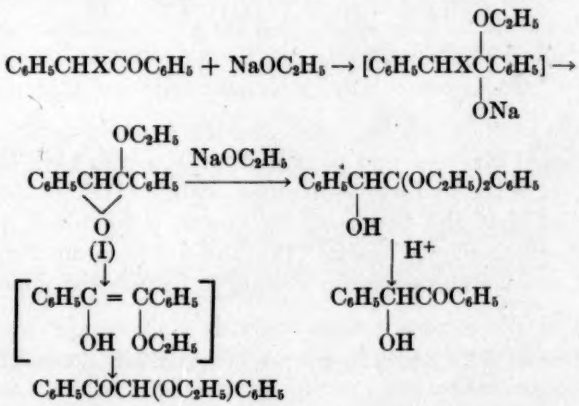
CHEMISTRY.—*The formation of hydroxy β-diketone acetates from bromo α-diketones.*[1] A. H. BLATT, Howard University.

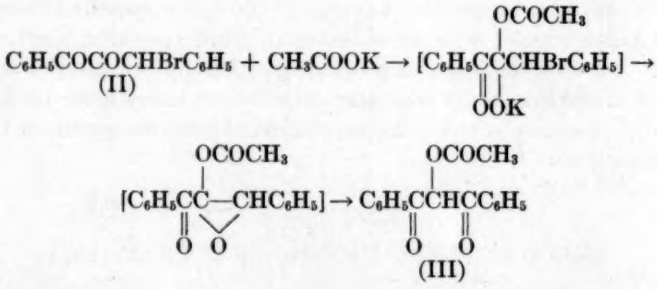
In recent years there has been accumulated a considerable amount of evidence which indicates that many of the replacement reactions of α-haloketones proceed through addition to the carbonyl group and subsequent ethylene oxide formation, followed by ring opening to furnish the final replacement product.[2] To cite a specific illustration, desyl halides react with alcoholates to form epoxides, such as (I), which can then undergo ring opening either by addition of a molecule of alcoholate or by rearrangement which takes place on heating or in the presence of acids. These possibilities are shown in the following equations:



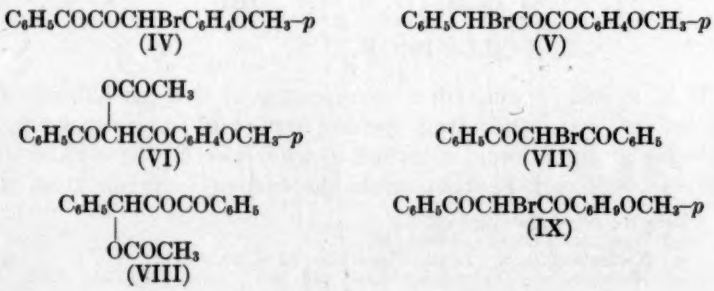
It is, it will be noticed, a consequence of this mechanism of replacement that, when ring opening occurs by rearrangement, the entering group is found attached to what was, in the α-haloketone, the carbonyl carbon atom, while the carbonyl oxygen atom shifts

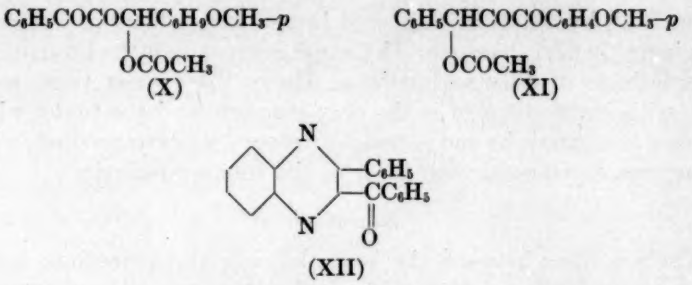
[1] Received November 19, 1937.
[2] (a) Ward, J. Chem. Soc., **1929**: 1541.
(b) Kohler and Brown, J. Am. Chem. Soc., **55**: 4299. 1933.
(c) Madelung and Oberwegner, Ann., **490**: 201. 1931; **526**: 195. 1936.

from its original location to an adjacent carbon atom. In the desyl halides such a shift, because of the symmetry of the molecule, would not reveal itself, and to the best of our information no one has sought to verify this consequence of the replacement mechanism just described by an examination of the products obtained from a substituted desyl halide. However, an extremely simple experimental test of the mechanism in question is possible if one starts not with a simple α-haloketone but instead with a halo α-diketone, for in this latter case the shift of the carbonyl oxygen atom will result in the formation of a derivative of a β-diketone. Thus, if phenyl bromobenzyl diketone (II) is subjected to a replacement reaction with, say, potassium acetate, the product should be the acetate of dibenzoylcarbinol (III).



We have verified this by examining the reaction between phenyl bromobenzoyl diketone and potassium acetate and have found that the product is the hydroxy β-diketone acetate (III). In addition we have found that the two isomeric bromo α-diketones, phenyl p-methoxybromobenzyl diketone (IV) and anisyl bromobenzyl diketone (V), react with potassium acetate to furnish the same hydroxy β-diketone (VI).





(X) (XI)

(XII)

In view of the foregoing discussion and facts it may appear surprising at first glance that bromodibenzoylmethane (VII) reacts with potassium acetate to yield the acetate (III) and not (VIII), and that *p*-methoxybromodibenzoylmethane (IX) with the same reagent furnishes the acetate (VI) and not (X) or (XI). In neither case does a shift of the carbonyl oxygen atom take place. In our opinion, however, there is no inconsistency in these results. Rather, they indicate that the replacement of a halogen atom in an α-haloketone need not of necessity proceed by way of addition and ethylene oxide formation. Instead, the reaction may follow a course comparable to that of the replacement of the halogen atom in an alkyl halide. Such a suggestion is in harmony with all the available facts for, with two competing reaction paths available, the course of the replacement process with a given reagent would be determined by the relative reactivities of the carbonyl group and the halogen atom. In the bromo α-diketones discussed in this paper there is present an extremely reactive carbonyl group activated by the adjacence of a second carbonyl group,[3] while in the bromo β-diketones under consideration there is present an unusually reactive halogen atom activated by adjacence to two carbonyl groups.

We have examined a number of other reactions of phenyl bromobenzyl diketone (II) in order to see whether they follow a course parallel to that with potassium acetate, but unfortunately in only two cases were the products sufficiently tractable to furnish definite information. With *o*-phenylene diamine, phenyl bromobenzyl diketone furnishes the halogen free quinoxaline (XII). The same quinoxaline is also obtained when bromodibenzoylmethane is treated with this reagent. The quinoxaline (XII) is derived, it will be noticed, from neither of the bromoketones but, instead, from diphenyl trike-

[3] Fuson, Matuszeski and Gray, J. Am. Chem. Soc., **56**: 2099. 1934 and earlier articles.

tone. With hydriodic acid, phenyl bromobenzyl diketone is reduced to phenyl benzyl diketone. The same reagent reduces bromodibenzoylmethane to dibenzoylmethane. Up to the present time, reduction with hydriodic acid is the only reaction we have found which, applied to isomeric bromo α- and β-diketones, leads to products whose structures correspond with those of the starting materials.

Experimental

The reactions between the bromoketones and potassium acetate were run in acetic acid using 10 cc. of solvent per gram of bromoketone. To the bromoketone dissolved in the solvent at its boiling point, was added 2.5 equivalents of fused potassium acetate. The acetate dissolved rapidly and within five minutes a heavy precipitate of potassium bromide separated. After thirty minutes the reaction mixture was cooled, diluted with water, and extracted with ether. The ether, on evaporation after appropriate washing and drying, furnished the hydroxy β-diketone acetate in a yield varying between 70 and 80 per cent. Dibenzoylcarbinol acetate (III) obtained from phenyl bromobenzyl diketone[4] was identified by comparison with an authentic specimen.[5] Benzoyl *p*-methoxybenzoylcarbinol acetate (VI) obtained from phenyl *p*-methoxybromobenzoyl diketone (IV),[6] from anisyl bromobenzyl diketone (V),[7] and from benzoyl anisoylbromomethane (IX)[8] is a colorless solid melting at 70° which is moderately soluble in the ordinary solvents. It can be distilled in high vacuum. For analysis it was crystallized from methanol. Anal. Calcd. for $C_{18}H_{17}O_6$: OCH_3, 9.91. Found: OCH_3, 10.13.

When bromodibenzoylmethane in alcohol containing acetic acid was boiled for a half hour with a molar equivalent of *o*-phenylene diamine the blood-red solution furnished, after the usual treatment, 2-phenyl-3-benzoylquinoxaline (XII) which was identified by comparison with a sample prepared according to Gastaldi and Cherchi.[9] The same quinoxaline was obtained from phenyl bromobenzyl diketone but only after vacuum distillation of the first oily reaction product.

Bromodibenzoylmethane dissolved in alcohol acidified with hydrochloric acid was reduced by the addition of potassium iodide. After

[4] Jörlander, Ber., **50**: 417. 1917.
[5] Neufville and Pechmann, Ber., **23**: 3375. 1890.
[6] Moureu, Ann. Chim., (10), **14**: 364. 1930.
[7] Jörlander, Ber., **50**: 410. 1917.
[8] Pond and Shoffstall, J. Am. Chem. Soc., **22**: 684. 1900.
[9] Gastaldi and Cherchi, Gazz. chim. ital., **43**: 1, 299. 1913.

removing the liberated iodine with thiosulfate, dilution of the alcohol with water precipitated dibenzoylmethane. Phenyl bromobenzyldiketone on similar treatment was reduced to phenyl benzyl diketone which was isolated as the antimony derivative.[10]

In order to test the possibility that the formation of the acetate (III) from the bromo α-diketone (II) might have been due to the rearrangement of a positive fragment, such as $C_6H_5C^+HCOCOC_6H_5$, after elimination of a bromide ion, we treated the bromo α-diketone (II) with pyridine, for the formation of a pyridinium salt would involve just such a process. The product of the reaction was an oily pyridinium salt which could not be purified and which was not identical with the product obtained from bromodibenzoylmethane and pyridine.[11]

On treatment with alcoholates, with phenylmagnesium bromide, with hydroxylamine hydrochloride and with ammonia, phenyl bromobenzyl diketone gave only intractable products.

Summary

Indirect replacement of the halogen atom in an α-haloketone should result, in certain cases, in a shift of the carbonyl oxygen atom from its original position to an adjacent carbon atom. This shift could easily be detected by employing halo α-diketones for with these ketones it would lead to derivatives of hydroxy β-diketones, and an examination of the reaction between some bromo α-diketones and potassium acetate shows that acetates of hydroxy β-diketones are formed. The structural factors which determine the course of replacement reactions of α-haloketones are briefly discussed and the conclusions from this discussion are shown to be consistent with the observed facts.

[10] Dufraisse and Moureu, Bull. soc. chim., (4) **41**: 1611. 1927.
[11] Kröhnke. Ber. **68**: 1180. 1936.

BOTANY.—*Additions to the grass flora of British Honduras.*[1] JASON R. SWALLEN, Bureau of Plant Industry.

Since the publication of "The Grasses of British Honduras and the Petén, Guatemala,"[2] two collections have been made in British Honduras which add many grasses to the flora. One of these was made by Rev. Dr. Hugh O'Neill in the Belize District, and the other by C. L. Lundell in the El Cayo District.

Several of the species in these collections were found for the first time outside of the United States, some are South American not before known from North America, others are Eastern United States and West Indian species found for the first time in Central America, while the rest were to be expected in British Honduras but have not previously been reported. There are also six species new to science.

Arthrostylidium spinosum Swallen, sp. nov.

Culmi scandentes, 5–15 m longi, ramis spinosis; vaginae (ramulorum) internodiis longiores, glabrae, fimbriatae, marginibus ciliatis; ligula firma, 0.2 mm longa; laminae lineares, 10–25 cm longae, 5–8 mm latae, infra glabrae, supra pubescentes, marginibus hispidis; paniculae rami curtissimi densi, axe curto pubescente; spiculae 3–10 cm longae, cylindricae, patentes vel adscendentes; glumae curtissimae; lemmata inferiora reducta; lemma flosculorum fertilium amplexans 15–18 mm longum, ad 7 mm latum, multinervium, acutum, aristatum; palea 10 mm longa, inter carinas ciliata, 1.5–2 mm lata, pubescens, marginibus latissimis 3-nerviis; stamina 3, 5–7 mm longa.

Culms clambering, 5–15 m long, hollow, thick walled, branching, the branches as much as 8 mm thick, with a solitary conspicuous spine (rarely two) and a dense fascicle of slender, stiff, leafy branchlets at each node; sheaths (of the branchlets) overlapping, the margins densely short ciliate, otherwise glabrous, with slender erect to flexuous fimbriae 2–3 mm long on the truncate shoulder; ligule firm, about 2 mm long; blades deciduous, linear, 10–25 cm long, 5–8 mm wide, firm, pungent, abruptly rounded at the base into a minute pedicel, scaberulous on both surfaces, often pubescent on the upper, the margins appressed hispid; panicles at the ends of leafy or nearly leafless branchlets, the branches very short, crowded on the short, pubescent axis; spikelets 3–10 cm long, about 2.5 mm thick, cylindric; glumes very small, scale like; rachilla joints striate, about half as long as the lemmas; lower lemmas much reduced, many-nerved, mucronate; fertile lemmas 15–18 mm long, as much as 7 mm wide clasping the base of the one above, many nerved, acute, aristate, the slender awns 3–5 mm long; palea 10 mm long, 1.5–2 mm wide between the ciliate keels, pubescent, the margins 3-nerved, glabrous, overlapping enclosing the flower; stamens 3, 5 mm long.

Type in the U. S. National Herbarium no. 1649171 collected along the Belize River at El Cayo, El Cayo District, British Honduras, June-August, 1936, by C. L. Lundell (no. 6939).

[1] Received November 16, 1937.

[2] SWALLEN, JASON R. Carnegie Inst. Washington Publ. **461**: 143–189. 1936.

This species of *Arthrostylidium* differs from all others in having prominent spines at nearly all the nodes. In this respect it resembles *Guadua*, but in that genus the florets have six stamens and the palea is winged, while in *Arthrostylidium* there are only three stamens and the palea is wingless.

Fournier[3] described *Chusquea spinosa* from sterile material collected in Oaxaca by Liebmann (no. 130). This appears to be the same species as the one described above, but since there were no flowering specimens, it can not definitely be determined.

ERAGROSTIS HIRSUTA (Michx.) Nees. Locally abundant in sandy pine-oak uplands, San Agustin, Mountain Pine Ridge (*Lundell* 6738). First record outside of the United States. Dry fields and open woods, southeastern United States and British Honduras.

TRIPLASIS PURPUREA (Walt.) Chapm. On the strand, Puerto Cortez, Honduras (*O'Neill* 8423). First record outside of the United States. Open sandy ground, eastern United States and Honduras. Although not properly belonging to the flora of our region, this species is noted here because of the great extension of range which the above collection records.

ARISTIDA IMPLEXA Trin. Locally abundant in sandy pine uplands, San Agustin, Mountain Pine Ridge (*Lundell* 6904). Plains, rocky slopes and pine woods, British Honduras, Salvador, and Panama; Brazil to Paraguay.

ARISTIDA PURPURASCENS Poir. In tropical pineland, Old Hector Creek (*O'Neill* 8438). First record outside of the United States. Dry sandy soil, eastern United States and British Honduras.

ARISTIDA LONGIFOLIA Trin. Rare in wet sand at edge of stream, Rio On, Mountain Pine Ridge (*Lundell* 6801). First record from North America. Sandy, open or brushy ground, British Honduras; eastern Brazil.

ARISTIDA TENUISPICA Hitchc. Common in sandy pine uplands. San Agustin, Mountain Pine Ridge (*Lundell* 6815). First record outside of Florida. Pine woods, southern Florida and British Honduras.

Digitaria multiflora Swallen, sp. nov.

Annua; culmi graciles, erecti, simplices vel ramosi, glabri; vaginae internodiis longiores, carinatae, glabrae, basi in marginibus sparse pilosae; ligula membranacea, 2–3 mm longa; laminae planae, acuminatae, 10–28 cm longae, 4–8 mm latae, glabrae vel scaberulae, supra sparse papilloso-hirsutae, marginibus scabris; racemi 8–25, 6–15 cm longi, graciles, adscendentes; pedicelli teretes glabri vel sparse scabri 1–4 mm longi; spiculae 1.2 mm longae ternatae; gluma prima obsoleta; gluma secunda 1 mm longa, acuta, 3-nervia, inter nervos et in marginibus dense pubescens; lemma sterile quam lemma fertile paulo brevius, acutum, 3-nervium, inter nervos et in marginibus sparse vel dense pubescens; lemma fertile 1.1 mm longum, acutum, fuscum, striatum.

Annual; culms slender, erect, simple or sparingly branched, 50–115 cm tall, glabrous; sheaths longer than the internodes, keeled, glabrous, the margins more or less pilose or ciliate toward the base; ligule membranaceous, brownish, 2–3 mm long; blades flat, acuminate, 10–28 cm long, 4–8 mm wide, smooth or scaberulous on both surfaces, sparsely papillose-hirsute on the upper at least toward the base, the margins scabrous; axis of the inflorescence 8–15 cm long; racemes 8–25, 6–15, cm long, slender, ascending or

[3] FOURNIER in Hemsl. Biol. Centr. Amer. Bot. 3: 587. 1885.

sometimes spreading, rather evenly scattered along the axis, the rachis wingless, 0.3 mm wide, the margins scabrous; spikelets 1.2 mm long, in groups of 3 or 4, the unequal pedicels terete, glabrous or sparsely scabrous, 1–4 mm long, somewhat spreading; first glume obsolete or nearly so; second glume 1 mm long, acute, narrower than the fruit, 3-nerved, with dense lines of white pubescence on the internerves; sterile lemma a little shorter than the fruit, acute, 3-nerved, pubescent like the second glume but the hairs shorter, sometimes nearly wanting on the internerves; fruit 1.1 mm long, extending slightly beyond the second glume and sterile lemma, acute, dark brown, striate.

Type in the U. S. National Herbarium no. 1647576 collected in sandy pine-oak uplands, San Agustin, Mountain Pine Ridge, El Cayo District, British Honduras, July-August, 1936, by C. L. Lundell (no. 6730).

The usually numerous spreading racemes with many minute spikelets are characteristic.

Digitaria cayoensis Swallen, sp. nov.

Annua; culmi erecti vel adscendentes, ramosi, 80 cm alti, glabri; vaginae internodiis longiores, dense hirsutae; laminae planae, acuminatae, ad 16 cm longae, 3–5 mm latae, scabrae, supra sparse pilosae; racemi 6–8, graciles, adscendentes, 8–12 cm longae; spiculae 1.5–1.6 mm longae, ternatae, pedicellis subplanis, scabris, 1–3 mm longis; gluma prima obsoleta; gluma secunda 1.3 mm longa, acuta, 3-nervia, inter nervos et in marginibus dense pubescens, pilis apice glumae paulo longioribus; lemma sterile quam lemma fertile paulo longius, 3-nervium, inter nervos et in marginibus pubescens, pilis quam pilis glumae secundae brevioribus; lemma fertile 1.4–4.5. mm longum, fuscum, acutum, striatum.

Annual; culms erect or ascending, sometimes geniculate and rooting at the lower nodes, freely branching, as much as 80 cm tall, glabrous; sheaths longer than the internodes, rounded, or keeled only toward the summit, densely hirsute, or the uppermost nearly glabrous, the hairs ascending or spreading; blades flat, acuminate, as much a 16 cm long, 3–5 mm wide, scabrous, the upper surface very sparsely pilose; axis of inflorescence 5–8 cm long; racemes slender, ascending, 8–12 cm long, pilose in the axils, the rachis 0.3 mm wide, the very narrow margins scabrous; spikelets 1.5–1.6 mm long, in groups of three, the unequal pedicels flattened, scabrous, 1–3 mm long; first glume nearly obsolete; second glume about 1.3 mm long, acute, 3-nerved, with dense lines of white hairs on the internerves and margins, the hairs near the tip somewhat longer than the others, extending slightly beyond the glume; sterile lemma a little longer than the fruit, 3-nerved, densely pubescent in lines on the internerves and margins, the hairs shorter than those on the second glume; fruit 1.4–1.5 mm long, dark brown, striate.

Type in the U. S. National Herbarium no. 1647578, collected in soil pockets in granite in stream-bed, San Agustin, Mountain Pine Ridge, El Cayo District, British Honduras, July-August, 1936, by C. L. Lundell (no. 6670).

This species is closely allied to the preceding but differs in having fewer racemes and larger spikelets, the pedicels of which are flattened and scabrous instead of terete and nearly glabrous.

Known also from Pocoboch, Yucatan (*Gaumer* 2494). This specimen was previously referred to *Digitaria filiformis*.

PASPALUM BLODGETTII Chapm. Locally abundant, San Agustin, Mountain Pine Ridge (*Lundell* 6714). Open or brushy places, southern Florida, the West Indies, Yucatan, Honduras and British Honduras.

PASPALUM CLAVULIFERUM Wright. On pine ridge. Maskall (*O'Neill*, 8451). Moist open ground and waste places, southern Mexico and the West Indies to Brazil.

PASPALUM CORCOVADENSE Raddi. Occasional at San Agustin, Mountain Pine Ridge (*Lundell* 6640). Native of Brazil; new to North America.

PASPALUM CORYPHAEUM Trin. Rare in wet sand of stream bed, Rio On, Mountain Pine Ridge (*Lundell* 6784). First record north of Panama. Savannas, brushy slopes, and river banks, British Honduras and Trinidad to Brazil.

PASPALUM NUTANS Lam. Rare, Cohune Ridge (*Lundell* 6525). Shady slopes, Central America and the West Indies to Brazil.

PASPALUM PILOSUM Lam. Locally abundant, Vaquero, Mountain Pine Ridge, (*Lundell* 6877). Occasional, San Agustin, Mountain Pine Ridge (*Lundell* 6659). Wooded slopes and brushy savannas, British Honduras to Bolivia and Brazil.

PASPALUM REPENS Berg. Deep water, Mussell Creek, 5 miles west of Boomtown, (*O'Neill* 8461A.). Floating in streams and ponds, southern United States to Paraguay.

PANICUM AGROSTOIDES Spreng. New River at Orange Walk, (*O'Neill* 8505). First record outside of the United States. Wet ground, eastern United States and British Honduras.

Panicum lundellii Swallen, sp. nov.

Perenne, glaucum; culmi erecti, crassi, rhizomatosi 2.5 m alti, glabri; vaginae purpurascentes, glabrae, marginibus ciliatus; ligula ciliata, 2 mm longa; laminae planae, attenuatae, 40–70 cm longae, 15–20 cm latae, glabrae, marginibus hispido-serratis; panicula 35 cm longa, ramis adscendentibus ad 15 cm longis, in parte inferiore nudis; spiculae 4–4.5 mm longae, glabrae; gluma prima acuta vel acuminata, 2.5–3 mm longa, 3-nervia; gluma secunda acuminata, 4–4.5 mm longa; lemma sterile acutum, 3–3.5 mm longum, obscure 5–7 nervium; fructus ellipticus, 2.5 mm longus, 0.9 mm latus, albescens.

Perennial, glaucous. Culms coarse, erect, 2.5–3 m tall, as much as 9 mm thick at the base, producing short rhizomes, glabrous; sheaths glabrous, or the margins ciliate, mostly a little shorter than the long internodes, deeply tinged with purple especially near the nodes; ligule ciliate, about 2 mm long; blades firm, flat, narrowed toward the base, attenuate-pointed, 40–70 cm long, 15–20 mm wide, glabrous, the margins hispid-serrate; panicle about 35 cm long, the branches narrowly ascending, naked in the lower half, the lower as much as 15 cm long; pedicels terete, glabrous, 1–5 mm long; spikelets 4–4.5 mm long, glabrous, usually tinged with purple; first glume rather abruptly acute or acuminate, 2.5–3 mm long, 3-nerved; second

glume abruptly acuminate, 4–4.5 mm long, 5-nerved; sterile lemma 3–3.5 mm long, acute, 5–7 nerved, the nerves rather obscure especially toward the base; fruit (immature) 2.5 mm long, 0.9 mm wide, elliptic, blunt, whitish.

Type in the U. S. National Herbarium nos. 1647561 and 1647562, collected in wet alluvial lowland, along Mahogany Creek, Mountain Pine Ridge, El Cayo District, British Honduras, July-August, 1936, by C. L. Lundell (no. 6903).

Panicum lundellii is closely related to *Panicum virgatum* L., but differs in having much stouter culms, which root at the lower nodes, and usually broader blades. The base of the type specimen is incomplete, there being only an extravaginal bud, which would indicate the plant produces rhizomes, but it is impossible to determine whether they are long or short. It seems probable, however, that they are much shorter than those of *P. virgatum*.

PANICUM NEURANTHUM Griseb. Edge of creek near Salt Creek (*O'Neill* 8454). Open ground, southeastern United States, the West Indies, and British Honduras.

PANICUM PARVIGLUME Hack. Occasional in patches, open places at top of limestone hill, San Agustin, Mountain Pine Ridge (*Lundell* 6809). This specimen differs from the typical form in having blades densely pubescent beneath. Along banks and ditches, Mexico to Costa Rica.

PANICUM PATULUM (Scribn. & Merr.) Hitchc. In tropical pineland, Boomtown (*O'Neill* 8430). Low woods, southeastern United States, Hispaniola, and British Honduras.

PANICUM POLYCAULON Nash. In tropical pineland, Boomtown (*O'Neill* 8480). Sandy pine woods, southeastern United States, the West Indies, and British Honduras.

PANICUM SELLOWII Nees. Occasional at San Agustin, Mountain Pine Ridge, (*Lundell* 6734). Rocky places, the West Indies, British Honduras, Venezuela and Brazil.

Ichnanthus lagotis (Trin.) Swallen, comb. nov.

Panicum lagotis Trin. Mem. Acad. St. Pétersb. VI. Sci. Nat. 1: 326. 1834.

Rare along roadside in limestone valley, San Antonio (*Lundell* 6941). First record in North America. Open woods and brushy borders, British Honduras; eastern Brazil.

Ichnanthus villosus Swallen, sp. nov.

Perennis; culmi erecti vel decumbentes, 90–110 cm longi, ramosi; vaginae internodiis breviores, dense villosae; ligula truncata, 0.5 mm longa; laminae lanceolatae, 8–13 cm longae, 12–20 mm latae, infra pubescentes, supra scabrae et pilosae; panicula 25 cm longa, ramis gracilibus divergentibus, ad 11 cm longis, sparsifloris; spiculae 4–4.5 mm longae, appressae; gluma prima acuta, 3-nervia, scabra; gluma secunda et lemma sterile subequalia, 5-nervia, acuta; lemma fertile 3.3 mm longum, glabrum, lucidum, appendicibus 0.7–0.8 mm longis, subhyalinis.

Perennial; culms erect or decumbent at the base and rooting at the lower nodes, 90–110 cm long, sparingly branched; sheaths shorter than the inter-

nodes, rather densely villous, ligule membranaceous, truncate, more or less ciliate, 0.5 mm long; blades lanceolate, acuminate, asymmetric, 8–13 cm long, 12–20 mm wide, softly pubescent on the lower surface, scabrous and pilose on the upper; panicle about 25 cm long, the slender branches stiffly spreading, the middle ones longest, as much as 11 cm long, with one to few branchlets at the very base; spikelets 4–4.5 mm long, appressed, usually in pairs, one on a pedicel 8–20 mm long, the other on a much shorter pedicel; first glume acute or subacuminate, 3-nerved, scabrous; second glume and sterile lemma nearly equal, acute or blunt, 5-nerved, more or less scabrous, extending well beyond the fruit; fruit 3.3 mm long, narrowly elliptic, blunt, smooth, shining, the wings subhyaline, 0.7–0.8 mm long, rather broad.

Type in the U. S. National Herbarium no. 1647573, collected in sand along creek at Vaquero, Mountain Pine Ridge, El Cayo District, British Honduras, July-August, 1936, by C. L. Lundell (no. 6852). Also collected along the Rio On, El Cayo District (*Lundell* 6785).

Ichnanthus villosus resembles *I. leiocarpus* (Spreng.) Kunth, but in that species the first glume and the fruit are as long as the second glume and sterile lemma, and the wings of the fertile lemma are more conspicuous, 1.2–1.3 mm long.

SETARIA TENAX (L. Rich.) Desv. Occasional in sandy pine-oak uplands, San Agustin, Mountain Pine Ridge (*Lundell* 6731). Open or brushy places, Mexico and the West Indies to Brazil.

ERIOCHRYSIS CAYENNENSIS Beauv. Locally abundant, San Agustin, Mountain Pine Ridge (*Lundell* 6628). Wet ground, southern Mexico and the West Indies to Paraguay.

ANDROPOGON ELLIOTTII Chapm. Common in sandy pine uplands, San Agustin, Mountain Pine Ridge (*Lundell* 6727). Occasional in wet sand in stream bed, Rio On, Mountain Pine Ridge (*Lundell* 6785). Open ground, eastern United States, Cuba, and British Honduras.

ANDROPOGON LATERALIS Nees. On granite along stream, Rio On, Mountain Pine Ridge (*Lundell* 6791). Grassy places, Cuba and British Honduras; Colombia and Brazil to Argentina.

SORGHASTRUM SETOSUM (Griseb.) Hitchc. Occasional in sandy pine uplands, San Agustin, Mountain Pine Ridge (*Lundell* 6865). In tropical pineland, Boomtown (*O'Neill* 8481). Grassy hillsides and pinelands, southern Mexico and the West Indies to Argentina.

ZOOLOGY.—*Stored nutritive materials in the Trophosome of the nematode,* Agamermis decaudata (*Mermithidae*).[1] B. G. CHITWOOD and LEON JACOBS, Bureau of Plant Industry.

During parasitic development, colorless globules accumulate in the intestine of *Agamermis decaudata,* Cobb, Steiner and Christie, 1923, and during adult free-living life these globules gradually disappear. Since the greater part of the globules are insoluble in alcohol-xylol, Rauther[2] pointed out that they are not fat. In the present note the results of our observations on the globules of this *Agamermis* are presented.

Strong Flemming's mixture or osmic vapor blackens only a small proportion (about 10 per cent) of the globules; alcohol, xylol, ether, and chloroform remove about the same proportion of globules, and after such treatment osmication is without effect. Nile blue sulphate, prepared by the method of Smith,[3] stains the majority of the globules blue (indicating a fatty acid according to Smith) but a small proportion red (indicating a neutral fat according to Smith); only blue-coloration is observed after alcohol extraction. Scharlach R stains all globules. From these results it appears that a small proportion of the globules are neutral fat and that the majority contain some fatty acid but do not behave as do normal fatty acids.

Material previously extracted with alcohol contains most of the original globules. These give positive xanthoproteic and ninhydrin reactions and stain with gentian violet or haematoxylin, indicating their protein nature. When hydrolized in 10 per cent KOH the surface tension of the solution is reduced about 10 per cent as indicated by capillary tests with 10 per cent KOH as a control, the readings of the tests being 48 and 53 mm and the controls 52 and 59 mm respectively. This reduction in surface tension indicates the presence of a fatty acid.

Artificial gastric juice removes the majority of the globules from untreated material, supporting the conception that they are a protein. Hydrolysis with 10 per cent HCl produces the same effect. The residual globules after such treatment are stained red by Nile blue sulphate, and black with osmic acid, confirming the conclusion that they are a neutral fat.

The above observations show that the stored nutritive materials

[1] Received October 19, 1937.
[2] Zool. Jahrb., Abt. Anat. **23** (1). 1–76. 1906.
[3] Jour. Path. and Bact. **12**: 1. 1907.

of *Agamermis decaudata* are of two types; namely, a protein with reactions of a conjugated fatty-acid-protein, and a neutral fat. It is also indicated that Scharlach R and Nile blue sulphate are not specific tests for uncombined fat or fatty acid but may indicate the presence of a fatty-acid-protein complex. Substances which are stained by Scharlach R or Nile blue sulphate must be shown to be extractable in fat solvents, to be non-digestible in artificial gastric juice, and to give negative xanthroproteic and ninhydrin reactions, before it can be concluded that they are free fatty acids or neutral fats.

Preliminary observations indicate the presence of protein (?-fatty-acid-protein) globules in *Rhabditis strongyloides* Schneider (Rhabditidae), and *Ditylenchus dipsaci* (Kühn) Filipjev (Tylenchidae).

The writers are indebted to Mr. Jacob M. Schaffer, Mr. Robert R. Henley and Mr. Howard R. McMillin of the U. S. Bureau of Animal Industry for valuable suggestions.

ZOOLOGY.—*Nomenclatorial changes involving types of polychaetous annelids of the family Nereidae in the United States National Museum.*[1] OLGA HARTMAN. (Communicated by MARY J. RATHBUN.)

An examination of the types of polychaetous annelids deposited in the U. S. National Museum indicates a necessity for several changes of names in the family Nereidae. The following alphabetical list gives the original name, reference, type locality, museum catalog number, and revised name. Synonyms are enclosed in brackets.

[*Ceratonereis alaskensis* Treadwell] (Proc. U. S. Nat. Mus. **60**: 1–3, figs. 1–5, 1921) from Alaska, U.S.N.M. no. 19029, is *C. paucidentata* (Moore).

Ceratonereis bartletti Treadwell (Jour. Wash. Acad. Sci. **27**: 30–31, figs. 8–13, 1937) from western Greenland, U.S.N.M. no. 20224, is close to, if not identical with, *C. hircinicola* (Eisig). Area I of the proboscis lacks teeth, area III has a circular patch of 7 teeth; the jaw has 5 oblique teeth.

Ceratonereis gracilis n. comb., for *Nereis gracilis* Webster.

Ceratonereis irritabilis, n. comb., for *Nereis irritabilis* Webster.

Ceratonereis paucidentata, n. comb., for *Nereis paucidentata* Moore, includes *Ceratonereis alaskensis* Treadwell.

Ceratonereis pusilla, n. comb., for *Nereis pusilla* Moore.

[*Heteronereis caeruleis* Hoagland] (Bull. U. S. Nat. Mus. **100**: 608, pl. 47, figs. 13–16, pl. 48, figs. 1–4, 1920) from the Philippine Islands, U.S.N.M no. 18948, is a *Perinereis*. It is close to *P. camiguina* Grube, but differs in that the areas V and VI of the proboscis have numerous small flat plaques in addition to the single series of transverse plates characteristic of the genus *Perinereis*, also, areas I and II lack paragnaths. *P.*

[1] Received November 1, 1937.

neo-caledonia Pruvot (Arch. zool. éxp. Paris, **70**: 50–54, pl. 3, figs. 77–79) from New Caledonia, seems to be identical with *P. caeruleis*. This has already been suggested by Pruvot.

[*Leptonereis acuta* Treadwell] (Rev. Mus. Paulista São Paulo **13**: 3–5, figs. 1–7, 1923) from Brazil, U.S.N.M. no. 19030, is identical with *Leptonereis culveri* (Webster).

Leptonereis culveri, n. comb., for *Nereis culveri* Webster, includes *Leptonereis acuta* Treadwell.

[*Neanthes palpata* Treadwell] (Rev. Mus. Paulista São Paulo **13**: 5–9, figs. 6–15, 1923) from Brazil, paratype U.S.N.M. no. 19031, is a *Pseudonereis*. Transverse teeth are present on area VI, pointed cones are present on areas V, VII and VIII and rows of pectinae are on the maxillary ring.

[*Nereis brevicirrata* Treadwell] (Proc. U. S. Nat. Mus. **58**: 467–468, figs. 1–4, 1920) from Brazil, U.S.N.M. no. 18934, is a *Perinereis*. Area V of the proboscis has 2 conical teeth, side by side, area VI has 2 transverse teeth in similar arrangement but nearer the maxillary ring, areas VII and VIII have about 12 larger flattened cones on the oral side and an irregular row of smaller cones on the maxillary side; area I has 2 teeth in tandem.

[*Nereis culveri* Webster] (Ann. Rep. New York Mus. **32**: 111–113, pl. 3, figs. 23–30; pl. 4, figs. 31, 32, 1879) from New Jersey, U.S.N.M. no. 541, is a *Leptonereis*. Paragnaths are absent from both rings. Jaws are delicate, amber, with 9–12 closely set teeth; parapodia have greatly shortened dorsal and ventral cirri. The types of *N. culveri* and *Leptonereis acuta* agree favorably.

[*Nereis decora* Treadwell] (Rev. Mus. Paulista São Paulo **17**: 15–17, figs. 6–11, 1932) from Brazil, U.S.N.M. no. 19639, is identical with *Nereis riisei* Grube.

[*Nereis disparsetosa* Treadwell] (Rev. Mus. Paulista São Paulo **17**: 15–17, figs. 6–11, 1932) from Brazil, U.S.N.M. no. 19638, is a *Pseudonereis*, identical with *Ps. palpata*. Area VI of the proboscis has a transverse chitinous plate, area V a pointed cone, areas VII–VIII have 21 cones in a single continuous row. Posterior dorsal lobes are elongate, flattened, foliaceous, convex along the dorsal edge, the dorsal cirrus is inserted terminally. Jaws are dark brown, each with 6 indistinct crenulate teeth. Dorsal, middle and ventral parapodial lobes are pigmented.

[*Nereis eucapitis* Hartman] (Proc. U. S. Nat. Mus. **83**: 468–469, fig. 46, 1936) from California, U.S.N.M. no. 20198, is identical with *Nereis heterocirrata* Treadwell.

[*Nereis gracilis* Webster] (Bull. U. S. Nat. Mus. **25**: 313–314, pl. 9, figs. 29–35, 1884) from Bermuda, U.S.N.M. no. 4787, is a *Ceratonereis*. Paragnaths are absent from the oral ring. Paragnaths on the maxillary ring are arranged as follows: areas I and II none, areas II and IV each with about 9 to 12 tall, slender cones in a crescent. Jaws are light horny brown, each with 4 or 5 teeth. The name, *N. gracilis* is preoccupied by Hansen (Mém. cour. Belg. **44**: 10, 1882). Since, Webster's type is a *Ceratonereis*, no change seems necessary.

Nereis heterocirrata Treadwell (Proc. U. S. Nat. Mus. **80**: 1–2, figs. 1a–e, 1931) from Japan, U.S.N.M. 19323, includes *N. eucapitis* Hartman.

[*Nereis irritabilis* Webster] (Trans. Albany Inst. **9**: 231–234, pl. 5, figs. 56–64; pl. 6, figs. 65–69, 1879) from Virginia, U.S.N.M. no. 531–534, is a *Ceratonereis*. It differs from the widely known *C. hircinicola* (Eisig)

which it resembles in some respects, in having area III of the proboscis provided with a broad band of 3 or 4 irregular rows of teeth, which almost meet those of area IV, instead of having a subcircular patch. Transformation of parapodia in epitokous females is at the 31st parapodium.

[*Nereis* (*Neanthes*) *linea* Treadwell] (Proc. U. S. Nat. Mus. **83**: 268–270, fig. 19, 1936) from China, U.S.N.M. no. 20115, is a *Perinereis*, identical with *P. aibuhitensis* (Grube).

[*Nereis* (*Neanthes*) *orientalis* Treadwell] (Proc. U. S. Nat. Mus. **83**: 270–272, fig. 19, 1937) from China, U.S.N.M. no. 20116, is identical with *Perinereis aibuhitensis* Grube. The type is a male heteronereid.

[*Nereis paucidentata* Moore] (Proc. Acad. Nat. Sci. Philadelphia, pp. 430–431, pl. 24, figs. 28–30, 1903) from Alaska, U.S.N.M. no. 15709, is a *Ceratonereis*.

[*Nereis pusilla* Moore] (Proc. Acad. Nat. Sci. Philadelphia, pp. 428–429, pl. 24, figs. 25–27, 1903) from Japan, U.S.N.M. no. 15734, is a *Ceratonereis*. The specific name has been previously used by Bosc in 1802, and by Langerhans in 1879. Neither of these, belongs to the genus *Ceratonereis*, thus a change of name is unnecessary.

Perinereis aibuhitensis Grube (Mem. Acad. Sci. St. Petersburg **25**: 89–90, pl. 5, fig. 3, 1878) from the Philippine Islands, includes *Nereis linea* and *Nereis orientalis*, both from China.

Perinereis caeruleis, n. comb., for *Heteronereis caeruleis* Hoagland.

[*Platynereis integer* Treadwell] (Bull. Mus. Nat. Hist. **100**: 595–597, figs. 1–4, 1920) from the Philippine Islands, U.S.N.M. no. 18939, is identical with *Pl. polyscalma* Chamberlin (*vide* Monro, in Scientific Reports, **4**: 18, 1931, and Fauvel, in Voy. Indes orient. Neérlandaises, p. 23, 1931).

Platynereis polyscalma Chamberlin (Mem. Mus. Harvard **48**: 219) from the Gilbert Islands, U.S.N.M. no. 19449, includes *Pl. integer*.

[*Pseudonereis atopodon* Chamberlin] (Mem. Mus. Harvard **48**: 228, pl. 35, figs. 3–5, 1919) from the Tonga Islands, U.S.N.M. no. 19467, is identical with *P. palpata*.

Pseudonereis palpata, n. comb., for *Neanthes palpata* Treadwell, includes *Nereis disparsetosa* Treadwell and *Pseudonereis atopodon* Chamberlin.

Uncinereis agassizi (Ehlers) (Die Borstenwürmer, pp. 542–546, p. 23, fig. 1) from the Gulf of Georgia, British Columbia and Mendocino, California, includes *U. subita* Chamberlin.

[*Uncinereis subita* Chamberlin] (Mem. Mus. Harvard, 48: 215–219, pl. 30, figs. 1–4, 1919) from California, U.S.N.M. no. 19495, is identical with *U. agassizi* (Ehlers).

ZOOLOGY.—*Three new species of the amphipod genus* Ampithoe *from the west coast of America.*[1] CLARENCE R. SHOEMAKER, U. S. National Museum. (Communicated by WALDO L. SCHMITT.)

When examining collections of Amphipoda from the west coast of America from time to time, I have noted several specimens of *Am-*

[1] Published by permission of the Secretary of the Smithsonian Institution. Received November 4, 1937.

pithoe which did not appear to belong to any of the species with which I was familiar. After studying the literature of this genus, I have concluded that at least three new species are represented in the material. These new species, the descriptions of which follow, are *Ampithoe plumulosa* represented from Ecuador, Lower California, California, and British Columbia; *Ampithoe dalli* from Alaska, Bering Island, British Columbia, and Puget Sound; and *Ampithoe rubricatoides* from the Aleutian Islands and the Pribilof Islands, Alaska.

Family AMPITHOIDAE

Ampithoe plumulosa, n. sp. Fig. 1

Description of male.—Head with lateral lobes prominent, rectangular, corners evenly rounding. Eye rather small, oval, black. Antenna 1 longer than antenna 2, and over two-thirds the length of the body; first peduncular joint equal in length to the second, which is over three times the length of the third; flagellum over twice as long as the peduncle and composed of about forty-eight joints. Antenna 2 much stouter than antenna 1; fifth joint a little shorter than fourth; flagellum a little longer than fourth joint and composed of about twenty-eight joints; the anterior two-thirds of the lower margin of the fifth joint and the flagellum densely clothed with long plumose setae. Right mandible with six spines in spine-row; palp well developed, third joint shorter than second and very little, if at all, expanded distally, the obliquely rounding distal end bearing long curved setae. Maxilla 1, inner plate very short, conical, and bearing four setae on the outer margin, outer plate armed with ten spine-teeth. Maxilla 2 normal and as figured by Sars for *A. rubicata*. Maxillipeds, inner plate reaching beyond the base of the first joint of the palp, outer plate reaching to the end of the second joint of the palp. Lower lip very much as figured by Sars for *A. rubicata*.

Gnathopod 1 with side-plate produced far forward; second joint bearing a forward-pointing lobe on the outside distal corner; third joint with lobe on the inside front margin; fifth joint about four-fifths as long as the sixth with the hind margin produced into a shallow lobe; sixth joint with margins parallel, palm oblique, broadly and evenly rounding and defined by a spine; seventh joint greatly overlapping palm and finely serrate on inner margin. Gnathopod 2, second joint with outside distal corner produced into a forward-pointing lobe; third joint with inside front margin produced into a lobe; fifth joint about half the length of the sixth joint; sixth joint large and powerful, palm slightly oblique, central portion in old males occupied by a long, flat tooth, but in younger males evenly convex; seventh joint strongly curved so that when closed the apex meets the rather blunt defining angle of the palm. Peraeopods 1 and 2 alike except that 1 is slightly the longer; second joint somewhat expanded; fourth joint slightly expanded and slightly produced distally. Third peraeopod as represented by Fig. 1 m. Peraeopods 4 and 5 alike, but 5 a little the longer; second joint moderately expanded with hind margin produced below into a short, downward-pointing lobe; sixth joint with three or four stout spines on the lower hind margin, and a pair of smaller spines nearer the seventh joint. The seventh thoracic segment bears ventrally a median, forward-directed, translucent, lamellar, oval keel armed with marginal teeth, those on the anterior half pointing

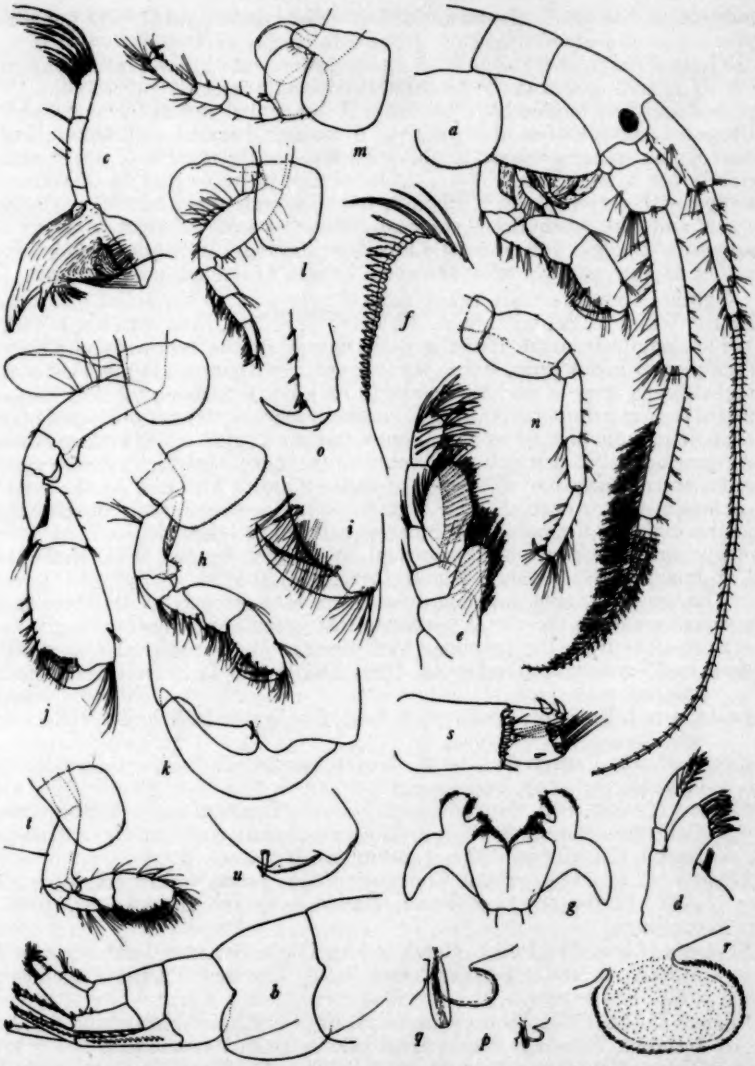


Fig. 1.—*Ampithoe plumulosa* n. sp., male. *a*, anterior end of animal; *b*, posterior end of animal; *c*, mandible; *d*, maxilla 1; *e*, maxilliped; *f*, outer plate of maxilliped, enlarged; *g*, lower lip; *h*, gnathopod 1; *i*, end of gnathopod 1, enlarged; *j*, gnathopod 2; *k*, end of gnathopod 2 of fully developed male, enlarged; *l*, peraeopod 1; *m*, peraeopod 3; *n*, peraeopod 4; *o*, end of peraeopod 4, enlarged; *p*, ventral, oval keel of seventh thoracic segment, drawn on the same scale as the peraeopods; *q*, keel on larger scale showing its situation in reference to the male genital organ; *r*, keel greatly enlarged showing the marginal teeth; *s*, uropod 3; *t*, gnathopod 2, ♀; *u*, end of same, enlarged.

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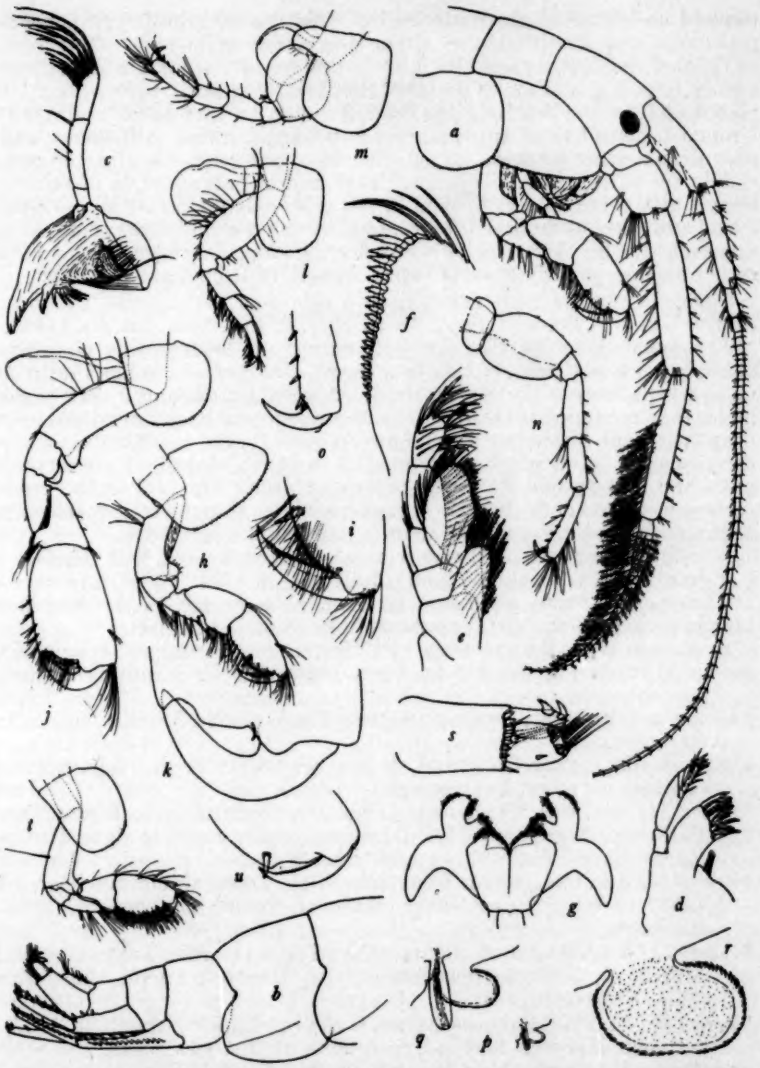

Fig. 1.—*Ampithoe plumulosa* n. sp., male. *a*, anterior end of animal; *b*, posterior end of animal; *c*, mandible; *d*, maxilla 1; *e*, maxilliped; *f*, outer plate of maxilliped, enlarged; *g*, lower lip; *h*, gnathopod 1; *i*, end of gnathopod 1, enlarged; *j*, gnathopod 2; *k*, end of gnathopod 2 of fully developed male, enlarged; *l*, peraeopod 1; *m*, peraeopod 3; *n*, peraeopod 4; *o*, end of peraeopod 4, enlarged; *p*, ventral, oval keel of seventh thoracic segment, drawn on the same scale as the peraeopods; *q*, keel on larger scale showing its situation in reference to the male genital organ; *r*, keel greatly enlarged showing the marginal teeth; *s*, uropod 3; *t*, gnathopod 2, ♀; *u*, end of same, enlarged.

forward and those on the posterior half pointing backward. The penes are prominent and are situated on either side of this keel.

Third abdominal segment with lower postero-lateral margin broadly and evenly rounding and lower postero-lateral angle scarcely perceptible. Uropods 1 and 2 extending back the same distance, but not as far as uropod 3. Uropod 1, distil half of upper margin of peduncle armed with spines, and a row of fine spines or setae on outer surface; outer margin of outer ramus closely set with spines. Uropod 2, distal half of outer margin of peduncle armed with three spines. Uropod 3, peduncle extending farther back than telson and without marginal spines, but bearing a row of short spines at the upper distal edge. Telson a little broader than long, sides converging to the rather narrow, slightly excavate apex. Length of animal about 16 mm.

Type.—A mature male taken from a tide pool at La Jolla, California, by Dr. Waldo L. Schmitt, Sept. 20, 1918, U. S. Nat. Mus. cat. no. 71443.

The female is much like the male except in the following characters. Side-plate 1 is not produced so far forward. Gnathopod 1 is like that of the male except there is no lobe on the third joint. Gnathopod 2 very slightly larger than gnathopod 1; third joint without lobe; sixth joint one-third longer than fifth, palm formed by an oblique compound curve which ends in a blunt defining angle below which is a stout spine; seventh joint slightly overlapping palm and bearing fine serrations on inner margin. The keel on the ventral surface of the seventh thoracic segment is not so prominently developed as in the male, and in some specimens is reduced to a low ridge.

The first specimens of this species were taken by Dr. Wm. H. Dall at Catalina Harbor, Catalina Island, California, in 1874.

The specific name *plumulosa* is given in reference to the prominent plumose setae on the distal portion of the second antennae.

Specimens from the following localities are in the national collection:

Salinas, Ecuador, September 12, 1926, Dr. Waldo L. Schmitt, collector, 4 specimens.

La Libertad, Ecuador, January 19, 1933, Dr. Waldo L. Schmitt, collector, 1 specimen.

La Ensenada, Lower California, November 28, 1936, low tide, Steve A. Glassell, collector, 7 specimens.

**Velero III* Sta. 639, San Lorenzo Channel, Espiritu Santo Island, Lower California, March 7, 1937, 3–5 fathoms, sandy coralline algae, Hancock Pacific Expeditions 1937, 4 specimens.

**Velero III* Sta. 683, outside Concepcion Bay, Lower California, March 15, 1937, 12 fathoms, corallines, Hancock Pacific Expeditions, 1937. 1 specimen.

**Velero III* Sta. 706, Puerto Refugio, Angel de la Guardia, Lower California, March 20, 1937, 8–10 fathoms, *Ulva*, Hancock Pacific Expeditions, 1937, 1 specimen.

**Velero III* Sta. 731. Tiburon Island, Gulf of California, March 28, 1937, 12 fathoms, Hancock Pacific Expeditions, 1937, 7 specimens.

San Diego, California, May 29, 1927, Wilbur Reed and Leroy Arnold, collectors, 1 specimen.

La Jolla, California, tide pools, September 1918, Dr. Waldo L. Schmitt, collector, 15 specimens, and 25 specimens received from the Scripps Institution.

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Corona Del Mar, California, January 31 to March 3, 1933, Mr. G. E. MacGinitie, collector, 1 specimen.
Newport Bay, California, November 15, 1933, Mr. G. E. MacGinitie, collector, 2 specimens, and July 14, 1935, 35 specimens.
Off Balboa, California, November 25, 1932, Mr. G. E. MacGinitie, collector, 1 specimen.
Long Beach, California, September 26, 1925, University of Southern California, 16 fathoms, 1 specimen.
Catalina Island, California, 1874, Dr. Wm. H. Dall, collector, 3 specimens, and 5 specimens collected by W. A. Hilton, Aug. 24, 1918.
Patos Island, Strait of Georgia, British Columbia, April 23, 1921. 3 specimens.

Ampithoe dalli n. sp. Fig. 2

Description of male.—Head with lateral lobes prominent and rectangular, corners evenly rounding. Eyes rather small, circular, black. Antenna 1 shorter than antenna 2, which is about one-half the length of the body; peduncle extending very nearly to the end of the fourth joint of antenna 2; second joint a little shorter than the first and a little over twice the length of the third; flagellum composed of about thirty joints. Antenna 2 rather robust; fourth and fifth joints about equal in length; flagellum composed of about eighteen joints and equal in length to the fourth and fifth peduncular joints combined. Mandible with rather stout palp; second joint shorter than the third; third expanding distally and with the obliquely truncate upper margin bearing the usual long curved spines. Maxilla 1 with small conical inner plate bearing one lateral seta; outer plate bearing ten serrate spine-teeth; palp with distal end rounding and bearing five straight spines below which are two slender setae. Maxilla 2, inner plate much narrower than outer. Maxilliped with inner plate rather short, bearing distally and on the inner margin long, slender setae, and at the inner distal corner a stout spine; outer plate reaching perhaps a little beyond the second joint of the palp and broadest a little beyond the middle, upper third of outer margin with curved spines, inner margin bearing the usual serrate spine-teeth; palp rather short and strong, first and second joints about equal in length, the third joint is a little shorter than first or second.

Side-plate 1 produced forward, but not so much so as in *A. plumulosa*. Gnathopod 1, second joint rather short and robust and with distal anterior corner produced into a lobe; third joint short, without anterior lobe; fourth joint with lower distal margin somewhat produced; fifth joint shorter than sixth, lower margin extended downward into a shallow lobe which is not at all produced forward; sixth joint with the oblique, slightly convex palm merging into the hind margin by an evenly rounding curve, palm defined by a stout spine; seventh joint fitting palm, but the apex extending beyond the defining spine. The inside surface and lower margin of all the joints, except the sixth and seventh, of gnathopod 1 are densely clothed in long plumose setae. Side-plate 2 about as deep as side-plate 1 and much longer than deep. Gnathopod 2, second joint shorter than sixth and with lower anterior corner produced downward into a prominent lobe; fourth joint rectangular; fifth joint short, lower part narrowly produced between fourth and sixth, a low protuberance on upper proximal margin; sixth joint strong and robust, front and hind margins divergent, front margin slightly convex and twice the length of the hind margin which is continued distally into a

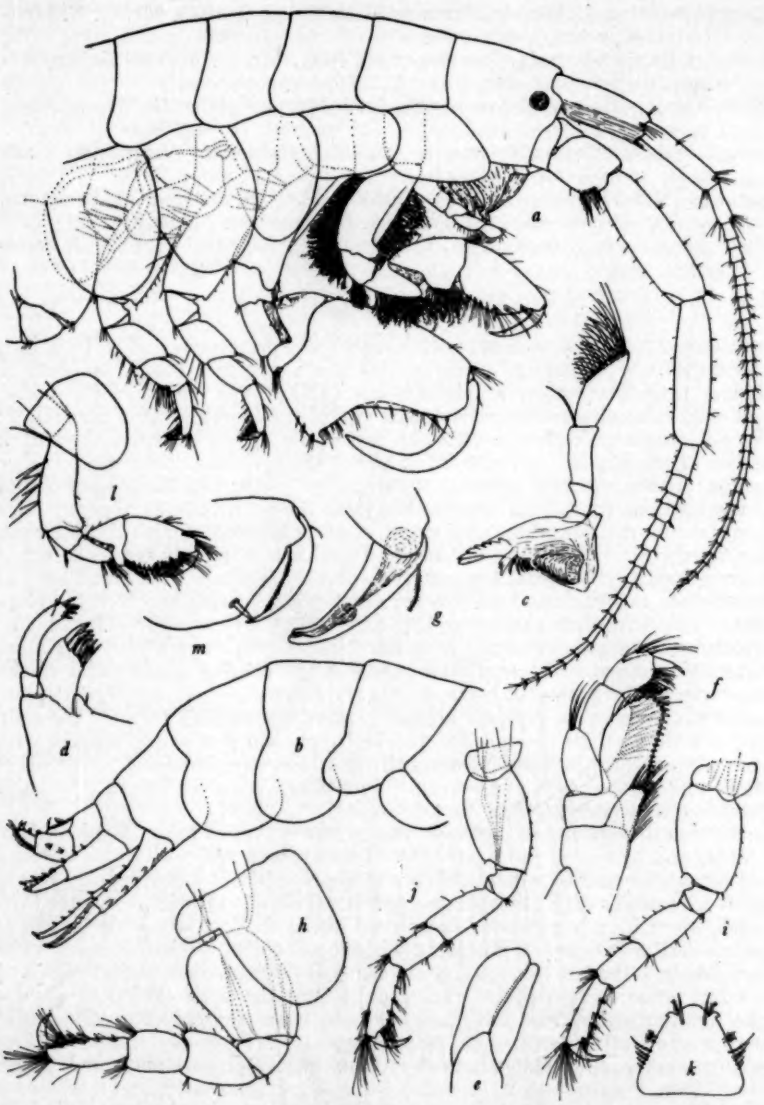

Fig. 2.—*Ampithoe dalli* n. sp., male. *a*, anterior half of animal; *b*, posterior half of animal; *c*, mandible; *d*, maxilla 1, *e*, maxilla 2; *f*, maxilliped; *g*, end of peraeopod 1, enlarged; *h*, peraeopod 3; *i*, *j*, peraeopods 4 and 5, drawn on a smaller scale than peraeopod 3; *k*, telson; *l*, gnathopod 2, ♀; *m*, end of same, enlarged.

forward-pointing tooth; palm very oblique and passing by an uneven concave curve from a prominent tooth near the dactyl hinge to the distal tooth of the hind margin. Seventh joint strong and very much curved, the apex meeting the palm some distance short of the tooth of the hind margin. Side-plates 3 to 5 much deeper than the two preceding and increasing slightly in depth from the third to the fifth, lower margins evenly rounding. Peraeopods 1 and 2 subequal in length; second and fourth joints only moderately expanded. Peraeopod 3, second joint longer than broad with hind margin produced into a rather flat lobe whose margin is slightly concave on the lower half; sixth joint bearing on the hind margin five stout spines which increase in length toward the seventh joint, which is strong and much curved. Peraeopods 4 and 5 much alike, rather short, but 5 slightly the longer; second joint very moderately expanded; sixth joint bearing five or six stout spines on front margin; seventh joint strong and much curved.

Pleon segments 1 to 3 with lower margins evenly rounding and no apparent lower postero-lateral angle on the third. Uropods rather short and stout. Uropod 1 reaching back only very slightly farther than 2; peduncle with very few spines on the upper inner and outer margins, and a few groups of fine spines or setae on the lower outer margin; rami with a few short spines on upper edges. Uropod 2 with rami much shorter than peduncle; upper outer edge of peduncle bearing three spines; rami bearing a few short spines on their upper edges. Uropod 3 extending back a little farther than 2; peduncle nearly twice as long as the rami and bearing no spines on the upper surface except the transverse distal row; the outer ramus bearing, besides the two terminal upward-pointing spines a group of slender spines on the central area of the upper surface. Telson about two-thirds the length of the peduncle of uropod 3, broadly triangular, with the sides, each of which bears a row of upward-pointing spines and two plumose setae, converging to a narrowly rounded apex bordered on either side by a hooked spine and a long slender spine. Length of male 15 mm.

Type.—A mature male taken by the steamer *Albatross*, June 24, 1914, at Yakutat Bay, Alaska, U. S. Nat. Mus. cat. no. 73274.

The species is named in honor of Dr. Wm. H. Dall, who collected the first specimens in 1873 in Kyska Harbor, Kyska Island, Alaska.

The female is like the male except in the first few side-plates and the gnathopods. Side-plates 1 and 2 are not longer than deep, as they are in the male, and side-plate 1 is not produced forward as much as in the opposite sex. Gnathopod 2 is very slightly larger and stronger than gnathopod 1, which is like that of the male, but without the plumose setae; sixth joint like that of gnathopod 1 except the palm is not evenly convex and does not merge into the hind margin by an evenly rounding curve, but is defined by a blunt rounding angle. Length of female 15 mm.

Specimens from the following localities are in the national collection:

Kyska Harbor, Kyska Island, Aleutian Islands, Alaska, 1873, beach, Wm. H. Dall, collector, 2 female specimens.

Lissonkovaya Bay, Bering Island, August 22, 1882, L. Stejneger, no. 1491, 1 female specimen.

Unalaska Island, Aleutian Islands, Alaska, May 26, 1906, taken by the steamer *Albatross*, 4 female specimens.

Attu Island, Aleutian Islands, Alaska, shore, June 10–11, 1906, taken by the steamer *Albatross*, 2 male specimens.

Adakh Island, Aleutian Islands, 1 male and 1 female specimen.

Ucluclet, British Columbia, May 19, 1909, John Macoun, collector, no. 9, 4 specimens, male and female; and no. 10, 1 male specimen.
Observation Island, Alaska, June 27, 1914, taken by the steamer *Albatross*, 3 specimens.
Neah Bay, Puget Sound, April 27, 1914, taken by the steamer *Albatross*, 1 male specimen.
Yakutat Bay, Alaska, June 24, 1914, taken by the steamer *Albatross*, 1 male specimen.
Friday Harbor, Puget Sound, in eel grass. August 5, 1928, Mr. K. L. Hobbs, collector, 25 specimens, male and female.
False Bay, Puget Sound, August 12, 1928, Mr. K. L. Hobbs, collector, 1 female specimen.

Ampithoe rubricatoides n. sp. Figs. 3, 4

Description of male.—Head, lateral angle with upper front corner broadly rounding, lower corner scarcely perceptible, front of lobe passing by an almost straight line into the lower front margin of head; eye small, round, very pale in alcohol, and about the same color as the rest of the head. Antenna 1 apparently a little shorter than antenna 2; second peduncular joint a little shorter than first and a little over twice as long as third; flagellum a little shorter than peduncle and composed of about twenty joints. Antenna 2, fourth joint a little longer than fifth; flagellum equal to or a little longer than the fourth and fifth joints combined and composed of about fourteen joints; the lower margin of the fifth peduncular joint and the lower margin of the flagellum bearing conspicuous groups of setae. Mandible with small tooth on anterior edge of triturating surface of molar and a racket-like spine and a simple spine on the upper corner, a very conspicuous grooved prominence near the base of the palp; six spines in spine-row; palp rather short and stout, second joint about half the length of the third, the upper edge of which is very obliquely truncate. Maxilla 1, inner plate with one marginal seta; outer plate with ten simple, curved spine-teeth; rounding apex of palp bearing five slender spines and upper inside margin with five or six longer spines, Maxilla 2, outer plate not much wider than inner; apex and upper half of inner margin of outer plate with long spines; apex and entire inner edge of inner plate with long spines. Maxilliped very much like that of *A. dalli*, inner plate extending a little beyond the base of the first palp joint, apex rounding, with no apical teeth, but apex and inner margin bearing long spines; outer plate extending a little beyond the end of the second palp joint, upper half of outside margin and rounding apex armed with long curved spines, inner margin with the usual spine-teeth, which do not appear to be serrate; palp short and stout.

Side-plate 1 produced moderately forward. Gnathopod 1, second joint bearing forward-pointing lobe on the lower front corner; fifth joint over half the length of the sixth; sixth joint widest through the middle; palm very oblique, defined by a spine and passing by a scarcely perceptible angle into the hind margin, both palm and hind margin of sixth joint bearing conspicuous setae; seventh joint fitting palm, but slightly overlapping it. Gnathopod 2 much resembling gnathopod 1 but larger and stronger, and the lower front lobe of the second joint is less produced; sixth joint stout and strong, widest through the middle, palm oblique, concave, and forming a blunt angle with the hind margin, a submarginal palmar spine on inside surface of joint just before the defining angle; seventh joint strong, moder-

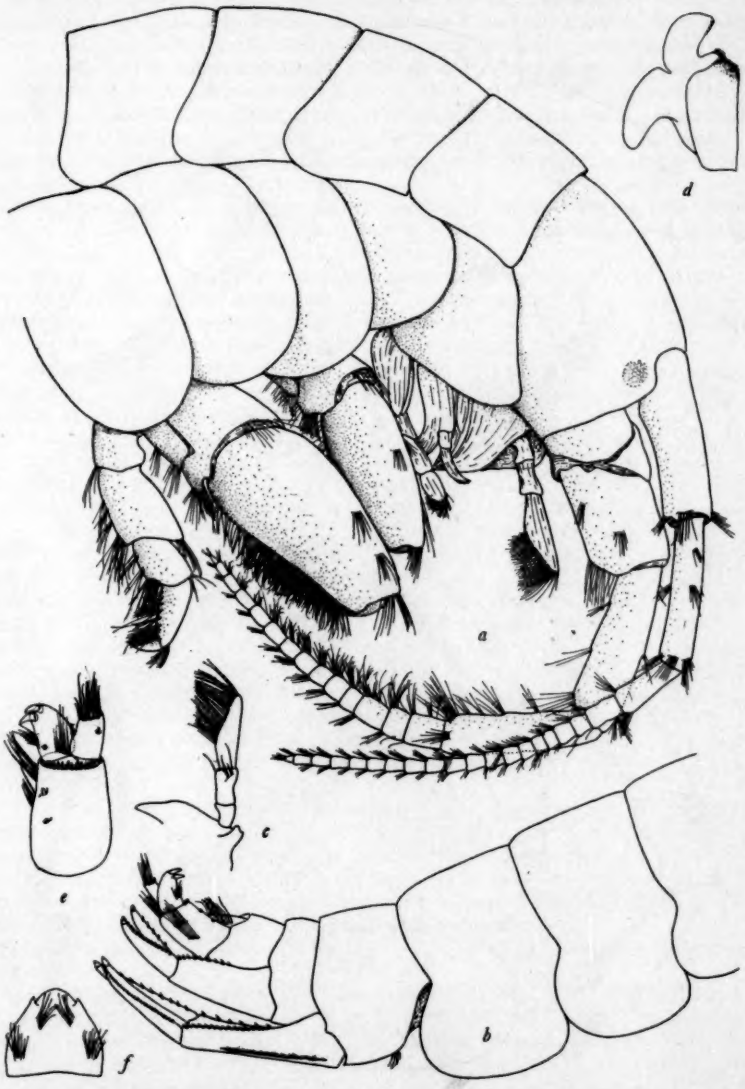

Fig. 3.—*Ampithoe rubricatoides* n. sp., male. *a*, anterior end of animal; *b*, posterior end of animal; *c*, mandible; *d*, lower lip; *e*, uropod 3, enlarged; *f*, telson.

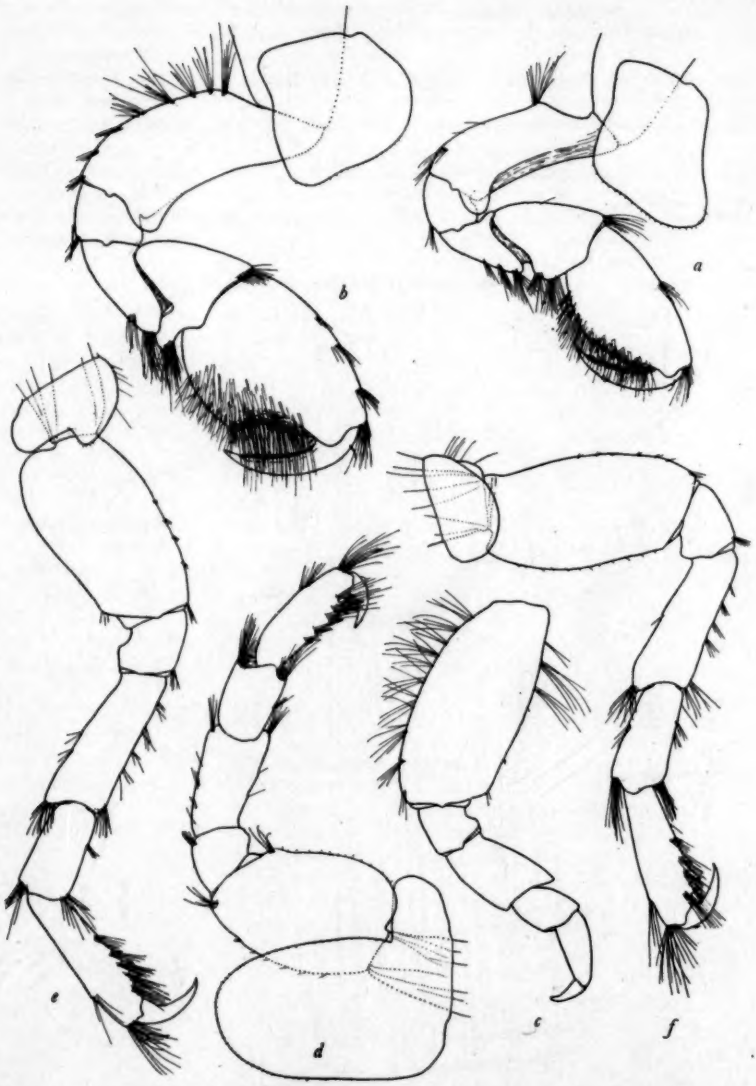

Fig. 4.—*Ampithoe rubricatoides* n. sp., male. *a*, gnathopod 1; *b*, gnathopod 2; *c*, peraeopod 1; *d*, peraeopod 3; *e*, peraeopod 4; *f*, peraeopod 5.

ately curved, not fitting palm when closed, but apex resting on the inside of sixth joint against the submarginal spine; the palm and lower surface of sixth joint conspicuously setose. Peraeopods 1 and 2 subequal in length, second joint moderately expanded; fourth joint moderately expanded with lower front corner produced slightly downward. Peraeopod 3, second joint longer than wide and widest across upper third; sixth joint armed on hind margin with about five stout spines. Peraeopods 4 and 5 very much alike, but 4 a little the longer, second joint moderately expanded; sixth slightly expanded distally and armed on hind margin with five stout spines; seventh joint strong and much curved.

Pleon segments 1 to 3, lower postero-lateral margins merging into lower margins by a broad evenly rounding curve. Uropod 1 reaching back a little farther than 2, rami about two-thirds the length of the peduncle, peduncle with the distal two-thirds of the upper outer edge furnished with a row of short closely-set spines, while the spines on the upper inner edge are set farther apart, lower outer edge provided with a row of fine setae; outer edge of outer ramus with fine closely-set spines throughout, inner edge apparently without spines; inner edge of inner ramus with spines set farther apart than those of outer ramus, the opposite edge apparently without spines. Uropod 2, rami about three-fourths the length of the peduncle; the distal half of upper, outer edge furnished with short closely-set spines; armature of rami the same as in uropod 1. Uropod 3 extending back very little beyond 2, rami a little over half the length of the peduncle, which bears two very short spines on the upper surface, and a row of very short closely-set spines on the upper distal margin, outer side of peduncle with two groups of slender setae; outer ramus with the usual uncinate distal spines, a very short spine near the proximal margin of upper surface, and a group of setae on the outer surface; inner ramus bearing apically a transverse row of very short spines and a row of long slender setae. Telson as broad as long, and about reaching the end of uropod 3, sides converging by a convex curve to a narrowly rounding apex which is bordered on either side by a short blunt tooth or spine, upper surface with a group of setae proximally on either side and a group of setae distally nearer the center. Length of male 24 mm.

Type.—A mature male from Kyska Harbor, Kyska Island, Aleutian, Islands, taken in 1873 by Dr. Wm. H. Dall, 10 fathoms, U. S. Nat. Mus. cat. no. 74661.

The female is very much like the male in general appearance. Gnathopod 1 like that of the male. Gnathopod 2 very little larger than 1 and closely resembling it in form, but the palm is obliquely straight and not concave. The armature of uropods is the same as in the male. The females which I have seen are considerably smaller than the largest males, but these specimens may not have attained their greatest development.

There are in the collection of the U. S. National Museum the following specimens:

Kyska Harbor, Kyska Island, Aleutian Islands, Alaska, 1873, 9–12 fathoms, sandy, mud, collected by Dr. Wm. H. Dall, no. 164 (1001), 3 specimens.

Kyska Harbor, Kyska Island, Aleutian Islands, Alaska, in pass, 1873, 10 fathoms, collected by Dr. Wm. H. Dall, nos. 234 (1035), 235 (1036), and 236 (1037), 4 specimens.

Saint Paul, Pribilof Islands, Alaska, July 24, 1874, 6–9 fathoms, sand, collected by Dr. Wm. H. Dall, no. 721 (1163), 4 specimens.

ENTOMOLOGY.—*A new anobiid beetle from Alaska.*[1] W. S. FISHER, Bureau of Entomology and Plant Quarantine. (Communicated by E. A. CHAPIN.)

The beetles described in this paper were submitted for identification by James H. Condit from the Sheldon Jackson Museum at Sitka, Alaska, who reported them as doing considerable damage to the wooden articles in the museum, as well as to the surfaces of the supporting columns of the building.

Hadrobregmus destructor, n. sp.

Elongate, subcylindrical, brownish black (tarsi and antennae slightly paler), subopaque, rather densely pubescent.

Head deeply sunk within the prothorax, strongly carinate around the antennal bases, with a round, smooth, median spot beneath; front uneven; surface broadly, transversely depressed behind the eyes; finely, densely granulose, sparsely clothed with recumbent, brownish yellow hairs; maxillary palpus with the last segment elongate oval, pointed at apex, slightly wider than preceding segment; labial palpus with the last segment subtriangular, rounded on inner side, much wider than preceding segment. Eyes moderately large, strongly convex. Antenna 11-segmented; first and second segments robust, oblong; third to eighth segments narrow, not serrate, subequal in length; ninth, tenth, and eleventh segments slightly flattened, subequal in length, and together longer than the preceding segments united.

Prothorax distinctly narrower than the elytra, deeply excavated beneath for the reception of the head, which is received in repose upon the anterior coxae. Pronotum as wide as long; sides parallel anteriorly, acurately narrowed posteriorly; lateral margin irregular, distinct, strongly elevated at posterior angle; anterior margin strongly sinuate; disk strongly gibbose posteriorly; surface finely, densely granulose, rather densely clothed with moderately long, recumbent, brownish yellow hairs.

Elytra twice as long as wide, slightly wider behind the middles; sides nearly parallel from bases to apical fifths, then arcuately narrowed to the tips, which are conjointly broadly rounded; disk strongly convex; each elytron with about ten longitudinal rows of deep, coarse punctures; intervals from two to three times as wide as the punctures, feebly elevated basally, strongly, irregularly elevated apically; surface rather densely clothed with moderately long, recumbent, brownish yellow pubescence, which forms more or less distinct vittae between the alternate rows of punctures.

Body beneath finely, densely granulose, rather densely clothed with moderately long, recumbent, brownish white pubescence. Front and middle coxae widely separated, the antennae received between them. Metasternum not at all or only vaguely excavated in front, but with a broad, deep, median depression near the posterior margin. Abdominal sternites free, with the sutures straight; second sternite slightly longer than the fifth.

Length, 3.25–5.25 mm; width, 1.25–1.75 mm.

Type locality.—Sitka, Alaska.

Type and paratypes.—No. 52232, United States National Museum.

Described from 25 specimens (one type) collected in the Sheldon Jackson

[1] Received November 6, 1937. Paper No. 4250 of the Bureau of Entomology and Plant Quarantine.

Museum during July 1937 by James H. Condit. The work of this beetle is similar to that of the "European death-watch" beetle (*Anobium punctatum* De Geer). Mr. Condit reports this species as working in a dugout Thlinget canoe, an old deadfall trap, a birch canoe, and in the unpainted surfaces of the supporting columns of the building. The articles affected have been in the concrete building for some 45 years, but some ten years ago new wooden cases were installed and it is Mr. Condit's belief that the insects were brought in at that time.

This species resembles *Anobium punctatum* De Geer, but it differs from that species in being larger, in the pubescence on the elytra forming more or less distinct vittae between the alternate rows of punctures, and in not having the metasternum deeply excavated in front. It differs from the other known species of *Hadrobregmus* in having the pubescence on the elytra forming more or less distinct vittae.

ENTOMOLOGY.—*A new European species of* Epiurus, *parasitic on a leafmining sawfly* (*Hymenoptera: Ichneumonidae*).[1] R. A. CUSHMAN, Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK).

The new species described below was originally reared in Europe by agents of the Bureau of Entomology and Plant Quarantine, from mines of the sawfly leaf-miner of birch, *Phyllotoma nemorata* (Fallén). Living individuals brought to the United States were bred at the Melrose Highlands, Mass., laboratory of this Bureau. Some of the specimens on which the description is based are first-generation progeny of imported parents. Many were released in areas in New England infested by the host species, but at this writing no specimens of the parasite have been recovered.

The figure was drawn by Mary Foley Benson.

Epiurus foliae, n. sp. Fig. 1

Female.—Length 8.5 mm; antennae 5 mm; ovipositor sheath 4.5 mm.

In Schmiedeknecht's key to the European species of *Pimpla, sens. lat.* (Opuscula Ichneumonologica, Suppl., Bd. 18–19, 1933–1934) this species runs to *Epiurus inquisitor* (Scopoli), and agrees very closely with the description of that species except that the hind tarsus is pale, with only narrow apices of the joints dark, and that the propodeum is not striate posteriorly. Comparison of specimens shows the most striking difference between the two species to be in the form of the apical portion of the ovipositor, which in profile is strongly, concavely curved on the dorsal margin from the high point to the apex in *foliae* and is nearly straight in *inquisitor;* this is adequately shown in the accompanying figure. The epipleura are narrower in *foliae* than in *inquisitor* and the sclerotized portions of the abdominal sternites broader, broadly oval in *foliae* and elongately oval in *inquisitor*. Otherwise like *inquisitor* in structure, sculpture, and color.

[1] Received November 10, 1937. Paper No. 4269 of the Bureau of Entomology and Plant Quarantine.

Male.—Differs from male of *inquisitor* principally in the much smaller extent of dark color on hind tarsal joints, more than half of the basal joint being white.

Host.—*Phyllotoma nemorata* (Fallén).

Type locality.—Freistadt, Austria.

Type, allotype, and *paratypes.*—No. 52251, U. S. National Museum.

Paratypes.—British Museum; Paris Museum.

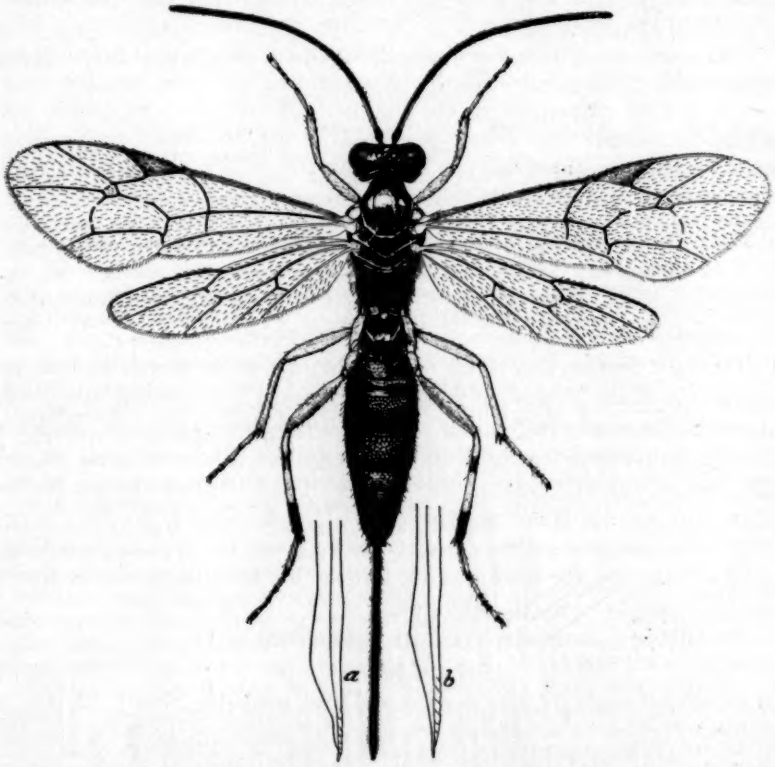

Fig. 1.—*Epiurus foliae* Cushman. *a*, apex of ovipositor; *b*, same of *Epiurus inquisitor* (Scopoli).

Three females (including holotype) and one male from the type locality, reared under Gipsy Moth Laboratory No. 13610 B, June 3, 1933 (holotype), October 8. 1932 and May 16, 1933; 10 females from the type locality, under No. 13610 B1, reared May 28, 1935; also 11 females and six males (including allotype) reared May 10, 1934, at Melrose Highlands, under No. 13613A, progeny of European specimens; and one male from Austria, reared in May 1934, under No. 13618, as a secondary parasite through *Phanomeris phyllotomae* Muesebeck.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

1111TH MEETING

The 1111th meeting was held in the Cosmos Club Auditorium, January 16, 1937, President WENNER presiding.

An address entitled *Explorations in the superconducting state*, illustrated by slides, was delivered by the retiring President, F. B. SILSBEE. This address was published in this JOURNAL **27**: 225–244. 1937.

1112TH MEETING

The 1112th meeting was held in the Cosmos Club Auditorium, January 30, 1937, Vice-President WOOLARD presiding.

Program: RICHARD M. FIELD, Princeton University: *Structure of continents and ocean basins.*—This address, which was published in this JOURNAL **27**: 181–195. 1937, was discussed by Messrs. MCNISH, FLEMING and GISH.

Ross GUNN: *On the origin of the continents and their motions.*—An approximate quantitative study has been made of the relation of the observed symmetry of the earth to certain aspects of geological evolution and to the problem of the origin of the solar system.

Geophysical data from several sources emphasize the unusual nature of the Pacific basin with its encircling mountain chains and suggests that the sub-Pacific layers of appreciable strength are slightly denser (1 or 2 per cent) than elsewhere. It is shown, as a result of this asymmetry and the isostatic adjustment of the continents, that the mass per unit area of the earth's outer shell in Pacific regions is about 3/100 per cent greater than in the continents. This relatively slight mass asymmetry is found to produce geologically important tangential forces on the continents of gravitational origin which frequently compress their boundaries playing an important part in mountain building and may actually produce continental motions. The force of North America urging it to the south and west, for example, approximates 10^{25} dynes and is adequate, or at least nearly adequate, to crush or produce over thrusting in the resisting Pacific basin, permitting continental motion with a velocity of the order of an inch per year. The author's earlier theory of the earth's origin, which was based upon purely astronomical facts (Phys. Rev., **39**: 130 and 311. 1932), is found to be particularly adapted to describe the origin of the continents and the observed asymmetry of their distribution. (*Author's abstract.*)

This was discussed by Messrs. GISH, BOWIE, FIELDS, PIGOT and WRIGHT.

1113TH MEETING

The 1113th meeting was held in the Cosmos Club Auditorium, February 13, 1937, President WENNER presiding.

Program: M. A. TUVE and L. R. HAFSTAD, Department of Terrestrial Magnetism of the Carnegie Institution of Washington: *Structural forces within the atomic nucleus.*—An important new physical force, in its way as fundamental and significant as the force of gravitation or that of electric attraction and repulsion, was directly observed and measured for the first time in the laboratory of the DTM, CIW, during the past year. This force

is an attraction between the component primary particles, protons and neutrons, causing them to aggregate and form the central nuclei of all atoms; thus, it underlies the existence and form of all larger things in the material universe. It has hitherto been inferred to exist, because atoms heavier than hydrogen are known. The truly basic physical forces are exceedingly few in number, and the initial observation and measurement of such a force is a correspondingly unusual event. It is worthy of emphasis that these measurements represent the attainment of one of the original objectives in a program of fundamental investigations begun ten years ago.

Two rather similar heavy units, protons and neutrons, form the massive nuclei of all atoms, the protons being electrically charged (positively). There exist as well two other units of small intrinsic mass, again similar to each other but both electrically charged, positive electrons, and the negative electrons which form the outer "shells" of all atoms; these latter units act as the chief connecting links between matter and energy in the form of electromagnetic radiation. The basic forces which bind together matter and energy to form atoms and then all larger material bodies are necessarily very few. They comprise the mutual interactions between protons and neutrons, the interactions between these units and electrons (positive and negative), and lastly the interactions of these several types of particles with energy in the form of radiation.

By experimentally measuring at different voltages the frequency with which high-speed protons from a well-defined beam are scattered through various angles as a result of single collisions with other relatively stationary protons in a given volume of hydrogen, a basis becomes available for important deductions as to the forces of interaction which protons exert on each other when separated by various specific small distances. The scattering to be expected on the basis of the familiar $(1/r^2)-$law of repulsion between like charges, assumed to hold even for minutely close distances of approach, was worked out by Rutherford and Darwin (1911–14) with the minor numerical modifications resulting from the quantum-mechanical identity of the two protons added later by Mott (1930).

Using the Department's 1200-kilovolt electrostatic generator, with the new high-resistance voltmeter and properly aligned tube to produce a highly homogeneous proton-beam of the desired adjustable energy, counts were made (using a linear amplifier) of the number of protons scattered through various angles when passing through a path, about 2 mm long, of hydrogen at a pressure of 12 mm. For angles in the range measured (15° to 50°) plural scattering is negligible for this case, both experimentally and theoretically, and the observed particles are primary and recoil-particles which enter the particular angular region under observation as a result of single collisions. The measurements, carried out for voltages of 600, 700, 800, and 900 kilovolts, were made on an absolute basis, with an accurately defined scattering-volume and with an angular definition of about 2°. For angles of 15° and 20° the observed scattering at each voltage was about two-thirds of that predicted by Mott's formula, whereas at 45° the scattering varied progressively with voltage from somewhat under Mott's value at 600 kilovolts to four times Mott's value at 900 kilovolts. Intermediate angles show correspondingly progressive changes.

Interpreted in terms of proton-proton interaction, these results show that at small distances, of the order of 5×10^{-13} cm or less, the ordinary inverse-square repulsion between like charges is overwhelmed by another proton-

proton force, which is shown to be an attraction, according to the careful quantum-mechanical analysis of our measurements by Breit, assisted by Professor Condon of Princeton and Professor Present of Purdue. As mentioned above, these new attractive forces explain the aggregation of protons and neutrons into groups to form the nuclei of the various elements of the atomic table, thereby accounting for their existence. A satisfying feature of these results is the fact that the observed variation of the anomalous scattering with angle and with voltage permits of a simple and direct interpretation on the basis of the "wave-mechanics" which has so successfully met all previous requirements as a description of atomic phenomena. In terms of this theory the observed proton-scattering is accounted for as a simple scattering (phase-shift) of the spherically symmetrical wave-component by a "potential-well" (superposed on the Coulombian potential) which has almost exactly the depth and width previously assumed for the proton-neutron interaction. Furthermore, no appreciable effect on the higher wave-components appears to be required.

Immediately after the announcement that these proton-scattering results led to a proton-proton interaction very similar to that hitherto assumed by theoretical physicists for the proton-neutron interaction, serious doubts were cast on the latter interaction by Goldhaber of the Cavendish Laboratory, who announced measurements on the scattering of neutrons by protons widely different from the expected values. We were just then undertaking similar measurements of nearly the same kind under well-defined conditions—possible through the use of artificial neutron-sources of high intensity. Because of the doubt arising from Goldhaber's measurements, however, a repetition of his neutron-scattering experiment was made, using the (carbon+deuteron)−neutrons instead of his photo-neutrons from deuterium. Our measurements agreed astonishingly well with the value predicted by theory. The observed cross-section for scattering was 4.2×10^{-24} cm², whereas the values predicted by Wigner's theory of the deuteron lie between 5.4 and 3.2×10^{-24} cm² depending on the values taken for the excited level of the deuteron and for the exact energy of the carbon neutrons used (600 to 1200 kilovolts, probably about 900). These measurements are being refined and extended.

It thus appears that the earlier conclusions by Breit on the basis of our proton-scattering results that the proton-neutron, proton-proton, and neutron-neutron interactions are identical is probably valid, and a real step has been made toward the final understanding of the forces underlying the structure and behavior of all matter. (*Author's Abstract.*)

These addresses were discussed by Messrs. WHITE and STEPHENS.

An informal communication on ball lightning was presented by L. B. TUCKERMAN. It was discussed by W. J. HUMPHREYS.

WALTER P. WHITE presented an informal communication on some unusual formation of ice crystals. This was discussed by Messrs. WENNER and HUMPHREYS.

1114TH MEETING

The 1114th meeting was held in the Cosmos Club Auditorium, February 27, 1937, President WENNER presiding.

Program: FRED L. MOHLER, National Bureau of Standards: *The vertical distribution of ozone from the sky spectrum.*—This was a report of results obtained in cooperation with Dr. Brian O'Brien and Mr. H. S. Stewart, Jr. of

Rochester University from the 1935 Stratosphere Flight of Major Stevens and Captain Anderson. Two spectrographs were carried for the purpose of measuring the vertical distribution of ozone in the atmosphere. One recorded the ultraviolet spectrum of sunlight while the second instrument photographed the sky spectrum at an angle of 9° above the horizontal. The amount of ozone above the balloon was computed from the sun spectrum by the conventional method. The ultraviolet intensity of the sky spectrum depends on the distribution of ozone in a layer extending 4 to 6 Km above the balloon. Previously published results from the sun spectrum indicate very little ozone below 15 Km and a rapidly increasing amount up to the ceiling of the flight at 22 Km. The sky spectra show that the amount of ozone is a maximum near 22 Km and drops rapidly to less than half the maximum amount at 25 Km. Half of the ozone in the atmosphere is below 27 Km. Results are published in full in National Geographic Society Contributed Technical Papers 2, 1936. (*Author's Abstract.*)

This address was discussed by Messrs. GISH, TUCKERMAN, DRYDEN, HAWKESWORTH and HUMPHREYS.

O. R. WULF, Bureau of Chemistry and Soils: *The atmospheric ozone equilibrium and its rate of maintenance.*—The hypothesis that the ozone of the atmosphere exists as a consequence of the photochemical action of solar radiation can be tested by computing the distribution with height which the ozone existing in the photochemical steady state should possess on this assumption. The results of such a treatment yield a distribution sufficiently in accord with observation to indicate that photochemical action can account for the major aspects of atmospheric ozone. (O. R. Wulf and L. S. Deming, Terr. Mag. Washington, **41**: 299. 1936; **41**: 375. 1936.) Critical for the calculations are the absorption coefficient of ozone and oxygen as a function of wave-length, and these are not as well known as might be desired. Atmospheric circulation can lead to disturbances in the photochemical steady state, and can cause the transportation of ozone into lower regions where it is stable, protected in large measure from photochemical action, thereby leading to high apparent vertical ozone paths. These effects can be illustrated rather simply in the laboratory under conditions analogous to the atmospheric case. Variations which have been observed under conditions where the change in the character of the air over the observer was fairly well known, suggest that such effects are probably of considerable importance in the well established changes which the vertical ozone path exhibits from day to day. (*Author's Abstract.*)

This was discussed by Messrs. MOHLER, HUMPHREYS and GISH.

1115TH MEETING

The 1115th meeting was held in the Cosmos Club Auditorium, March 13, 1937, President WENNER presiding.

The seventh Joseph Henry Lecture entitled *Fundamentals of photosynthesis* was delivered by JAMES FRANCK of Johns Hopkins University. It was published in this JOURNAL **27**: 317–329. 1937.

1116TH MEETING

The 1116th meeting was held in the Cosmos Club Auditorium, March 18, 1937, as a joint meeting with the Washington Academy of Sciences, President Thom presiding. ROBERT R. MCMATH of the University of Michigan gave an address on *Solar phenomena in motion pictures* and *A motion picture journey to the moon.*

1117TH MEETING

The 1117th meeting was held in the Cosmos Club Auditorium, March 27, 1937, President WENNER presiding.

Program: EDGAR W. WOOLARD, U. S. Weather Bureau: *The physical basis of air mass analysis.*—This paper drew attention to the fact that meteorology, considered as the scientific investigation of weather phenomena, is essentially a branch of physics; and outlined the nature of the physical analyses of weather phenomena that are now being used to aid in weather forecasting, with particular attention to air mass analysis. (*Author's Abstract.*)

H. R. BEYERS, U. S. Weather Bureau: *The practical analysis of synoptic data.*—While theoretical studies in meteorology for many years had pointed toward, and even had arrived at, the "counter-currents" theory, which was the basic form of the Norwegian concepts, the application of these ideas to the synoptic chart represented a more nearly revolutionary step; it was in practical synoptic meteorology that the Norwegians made their greatest contribution.

Air mass analysis on the synoptic chart involves delineating the air masses by locating the discontinuities or fronts which separate them. The rules for finding the fronts may be stated rather simply, but in practice the task often becomes difficult.

The proper analysis does not carry with it necessarily a correct prognosis. Neither do kinematic calculations alone, even if correct, produce an exact forecast of the weather. Thermodynamic processes and new developments in the moving systems themselves must be considered. Examples of these prognostic factors are provided by the maps of September 15 and 16, 1936. (*Author's Abstract.*)

H. WEXLER, U. S. Weather Bureau: *Some dynamical problems of air mass analysis.*—By considering the radiation exchange between a snow surface and a clear, calm, sunless atmosphere, it is possible to determine a relation between the temperature of the snow surface and the maximum free-air temperature. For the snow surface temperature to fall below the value given by this relation, the maximum free-air temperature must decrease; and the cooling process will be one whereby the atmosphere loses energy to space mostly through the spectral band of the black-body radiation emanating from the snow surface to which water vapor is transparent. As the cooling continues, the steep temperature lapse-rate characteristic of polar maritime or tropical air decreases until, finally, the atmosphere becomes practically isothermal from above the shallow surface layer of cold air to a certain height dependent on the initial lapse-rate. The cooled air mass is what may properly be called polar continental air, and is found covering extensive land and frozen maritime areas during winter.

When cooling of air over a certain region occurs, the air contracts, the isobaric surfaces are lowered, and the consequent inflow of air aloft raises the surface pressure, giving rise to a surface anticyclone. An explanation of the mechanics of the compensating inflow was attempted on the basis of the Brunt-Douglas isallobaric velocity component, which is directed into the deepening cyclone (polar cyclone) aloft. The vertical distribution of this inflow was studied and it was found that in going through the front from the polar continental air to the air above, a twenty-fold discontinuity in isallobaric velocity occurs, showing that almost all the increase in surface pressure results from convergence in the air above the lower cooled air.

At any given time in the life-history of the growing polar anti-cyclone it is possible to construct surface pressure tendency profiles, and the magnitude of these increases seems to be in satisfactory agreement with those observed on weather maps.

It was pointed out that the next step in the problem is to explain the release of these large masses of cold air, which occurs in a discontinuous manner, sometimes with no apparent clue from the shape of surface insobars. A few suggestions regarding this problem were made from the standpoint of the stability of the westerly winds above the polar wedge. (*Author's Abstract.*)

The first two papers were discussed by Messrs. GISH, HUMPHREYS, MCNISH, HAWKESWORTH, WULF and TUCKERMAN.

1118TH MEETING

The 1118th meeting was held in the Cosmos Club Auditorium, April 10, 1937, President WENNER presiding.

Program: I. C. GARDNER, National Bureau of Standards: *The 1936 solar eclipse in Russia.*—A nine-inch photographic objective was specially designed and constructed for eclipse photography. The design comprises two doublets and the relative aperture and field of view are $f/25$ and 4.5 degrees, respectively. If f denotes the focal length of the combination, $f/2$ and $-f/2$ are the focal lengths of the first and second doublets, respectively, and $f/4$ is the separation. With this design, if the same pairs of glasses are used in the two doublets and if each is separately achromatized, one has an achromatic system that also satisfies the Petzval condition. By "bending" the second doublet a flat field free from distortion is obtained, after which correction for spherical aberration and coma is obtained by "bending" the first doublet. An objective of this construction is of the telephoto type, an important advantage, as the total length of the camera is only three-quarters of the equivalent focal length. The lens was ground and polished by Mr. Robinson from glass produced in the optical glass plant of the National Bureau of Standards.

The camera proper was constructed of fabricated aluminum tubing with a plate-holder that moves on ways to compensate for the motion of the sun during an eclipse. The packing boxes were designed to serve as a base for the camera when set up at the eclipse station. With this construction one has an eclipse camera that can be focussed in the laboratory, rather than at the eclipse site. It is easily transported and can be erected in a few hours. The image of the sun is approximately two inches in diameter. The equivalent focal length and aperture of the lens have been selected so that the image is sufficiently large to enable the photographic plate to record all detail that is resolved by the lens. Consequently, it is considered that a photograph taken with this objective will show as much detail as if a lens of the same diameter had the much longer focal length such as is frequently characteristic of eclipse cameras.

Under the sponsorship of the National Geographic Society and the National Bureau of Standards, this lens was taken to Ak Bulak, in Asiatic Russia, to photograph the total solar eclipse of June 19, 1936. At the time of the eclipse the quality of seeing was excellent and eight exposures were made, six on Dufay color films and two on panchromatic process plates. A one-second exposure on the process plate showed the coma extending nearly a diameter from the sun's limb. With a ten-second exposure the longer coronal streamers extended beyond the limits of the 8×10 plate or

more than two solar diameters from the limb. The black-and-white photographs and one of the color pictures are reproduced in the February (1937) issue of the National Geographic Magazine. (*Author's Abstract.*)

This was discussed by Messrs. BRIGGS, BITTINGER, BRODE and HAWKESWORTH.

1119TH MEETING

The 1119th meeting was held in the Cosmos Club Auditorium, April 24, 1937, President WENNER presiding.

Program: W. J. MOXOM, U. S. Weather Bureau: *Ohio river flood of January–February 1937.*—The Ohio River flood of 1937 will long rank as one of the greatest floods, not only on account of the record-breaking stages, but for the unusual conditions that produced it and the numerous interesting features connected with it. Practically all the precipitation occurred from January 1st to January 24th with an exceedingly heavy rainfall during the the second half of this period. The total loss by flood damage will never be known. Mud was happily absent from most of the flooded areas. Another characteristic of the flood was the long duration of high stages. The long soaking received by Paducah, Ky., intensified the damage from submergence. Relatively, more of Paducah was affected than any other large community. Louisville suffered the greatest total loss of any city in the valley.

MERRILL BERNARD, U. S. Weather Bureau: *Plans for the development of river forecasting methods.*—One of Webster's definitions of the word philosophy is: Practical wisdom; calmness of temper and judgment; equanimity, as to meet misfortune with philosophy. The word can hardly be applied to human conduct at congested centers along our principal rivers during periods of major floods. One does not have to take part to visualize the disorder, panic and lawlessness accompanying such a catastrophe, for no more graphic story has ever been broadcast than that heard over the radio during the recent flood, in which the actual direction of flood rescue work at Louisville, Kentucky, was heard in millions of homes throughout the country. The news reel, too, has made the flood scene commonplace, so that all here have some conception of the misery and stark tragedy that follows in the wake of a calamitous flood.

Into a situation like this it is difficult to believe that such a thing as order can be injected. However, it is the hope of the Weather Bureau and other interested agencies, that, through careful coordination of effort, and the issuance of dependable and timely warnings all loss of life, much of the misery, and an appreciable part of the property damage may be prevented.

The undertaking requires not only the support of the meteorologist and the engineer, but the aid of those experienced in human relationships. I have seen children playing around a home that stood literally in the shadow of a levee whose top was being hastily raised a matter of 6 inches to prevent overtopping. In assisting in the evacuation of backwater areas of the Mississippi during the flood of 1927 I spent precious minutes in the effort to convince an old man that the approaching flood would exceed the depth of the famous flood of 1884, which he assured me could not be possible, returning the following day to pick him out of the branches of a tree. Highlights along the route of evacuation—the tragedy of an abandoned sow and litter; an expensive car with two exhausted calves draped over the hood; a lost child, an hysterical mother. And in the concentration camps—the comedy of a negro baby, bath, unexpected reunions, family feuds over clothes-line space, an improvised maternity ward. In short, the philosophy of floods and flood relief should make interesting reading.

A philosophic acceptance of the situation can be carried a bit too far, as in the case of the mother who, in her ordinary circumstances, worried but little over the uncertainty and irregularity with which food reached her table. She, with others from her neighborhood, found herself and family in one of the many concentration camps distributed along the border of the flooded area during the recent flood. For the first time she and her family were enjoying clean beds and good food. On the first morning, in her zeal to take full advantage of her opportunity, she hastened back to her tent, after having passed through the food line three times, to round up her flock and for once in their short lives to fill them up. Her instructions to the children were to get into the line and stay there until they were filled up or caught. In due time she strolled back to the center of camp and coming upon a crowd worked her way to the center to find her children spread out on the ground, all but unconscious. They had, in following her hurried directions, gotten into the line for typhoid inoculation.

It is the authorized function of the Weather Bureau to observe meteorological conditions throughout the country, measure river stages, forecast weather, issue storm and flood warnings, and carry on climatological research. The river forecasting work of the Bureau is carried on at some 50 odd river forecasting centers throughout the country. On the lower reaches of the principal rivers the Bureau has for many years accurately forecast and published, days and even weeks in advance, the approach of flood crests. A flood crest on a large river like the Mississippi or the Ohio travels rather slowly—about 40 miles per day—so that there is usually ample time to correct and refine a forecast at a lower river point before its arrival.

As the headwaters are approached, however, river stage prediction becomes increasingly complicated. The amount and rate of the rainfall, the slope of the land and the stream channel, the character of the watershed and its cover, and the influence of antecedent rainfall, factors which have been integrated into terms of stage on the lower river, now become variables which must be dealt with separately and quantitatively.

Our Nation is rapidly becoming flood conscious with the result that the Weather Bureau has been forced to extend its river forecasting service into the headwater areas of nearly all the principal streams. There has been neither time, nor opportunity, to prepare for basic changes which involve method and procedure wholly without precedent. Where the flood forecaster on the lower river has days to refine an estimate as the flood crest approaches, he has, at many of the important up-river stations, only a comparatively few hours to foretell the approach of a flood and that under the conditions of "flashy" streamflow typical of headwater tributaries. Pittsburgh is perhaps the best example of such a situation. Here the Allegheny and Monongahela Rivers combine to form the Ohio at the triangle so famous for its industrial wealth. The time of concentration at Pittsburgh for a large part of the contributing area is a matter of hours, and not days, and therefore any plan to meet this situation must be prepared to predict flood stage practically as the rain falls and snow melts. The City itself must be organized to evacuate certain areas with the precision of a fire department. Industry and business occupying danger zones must plan to waterproof against the rising water or be prepared with minimum notice to remove perishable and damageable goods to higher levels. This city, and other municipalities so situated, must maintain stand-by emergency water supplies and lighting facilities. Permanent concentration centers must be selected in advance and emergency

housing provided. These and other plans in considerable detail are being formulated by the agencies charged with responsibility of dealing with the great floods.

It is the plan of the Weather Bureau to establish ultimately over the watersheds of the headwater tributaries rain gages which record not only the total depth of rainfall, but the rate at which the rain is falling. In cooperation with the United States Geological Survey, run-off from many of the smaller watersheds will be measured. Certain of these watersheds will prove to be accurate indices of surface conditions over much larger areas and will indicate the extent to which the rain, as it falls, will appear as stream flow in the principal channel. The record of both rainfall and run-off being continuously recorded, will be transmitted immediately, either through arrangements with amateur broadcasters or automatic radio transmitters, to a central routing office, where the rainfall data will be quickly analyzed and converted into terms of streamflow. Thus, almost as quickly as rain falls, can its effect on river stage at points downstream be ascertained.

The first step in the expansion of the flood forecasting service has been made possible under a project in which the Weather Bureau, the Geological Survey, and the State of Pennsylvania are cooperating. Approximately 130 recording rain gages will be established in the watersheds of the Allegheny, Monongahela, Susquehanna and Delaware Rivers. These rain gages will be established on 3 circuits over which experienced hydrologic engineers will travel on schedule, attending and servicing the gages and, in season, conducting snow surveys. It is hoped that such cooperation may be established in other states.

Great floods have occurred periodically throughout the years and will continue to occur with painful regularity. Plans for flood control promise to reduce their magnitude and protect favorably situated areas, but as long as communities and industries find it profitable to occupy that portion of the stream channel intended by Nature for the passage of flood waters, accurate and timely flood forecasting and the methodical evacuation of stricken areas must be integrated into the National plan of river regulation and control. (*Author's Abstract.*)

The second paper was discussed by Messrs. TUCKERMAN and CURTIS.

L. B. TUCKERMAN presented an informal communication on *A curious Edison patent.* This was discussed by Messrs. MCNISH, HAWKESWORTH and SILSBEE.

1120TH MEETING

The 1120th meeting was held in the Cosmos Club Auditorium, May 8, 1937, President WENNER presiding.

Program: WILLIAM M. BLEAKNEY, National Bureau of Standards: *Dynamic strain gages.*—The recent demand for information on vibratory stresses developed in structures under service conditions has stimulated interest in dynamic strain gages, particularly of the recording type. One of the difficulties encountered in trying to apply existing strain gages to the measurement of dynamic strain has arisen from deformation within the gage caused by the inertia of the gage itself when subjected to high accelerations. These deformations in general affect the reading of the gage and may cause serious errors. It has been customary in the past to decrease the mass and increase the rigidity of the gage in an effort to minimize these deforma-

tions. The Tuckerman optical strain gage, modified for dynamic work, is the most precise instrument available at present. It is an example of the practical limit in the construction of rigid strain gages, but even it is subject to error under severe vibratory accelerations.

The new method (See N. B. S. JOURNAL of RESEARCH **18**: 1005. 1937.) consists in so adjusting the ratio of stiffness to inertia of the parts of the gage that these deformations are compensating. The indications of the instrument may thus be made independent of any acceleration of the gage as a whole. Methods of applying the compensation principle to various general types of gages were discussed with the aid of slides. The speaker also described a particular electromagnetic strain pick-up unit embodying this principle. It was designed by him in collaboration with the Massachusetts Institute of Technology and the Sperry Gyroscope Company for the Navy Department, for the purpose of recording strains in airplanes during flight.

A third method, developed by DeForest (See AERONAUTICAL SCIENCES **4**: 227. 1937.), makes use of a light flexible resistance unit which is glued directly to the specimen in which the strain is to be measured. (*Author's Abstract.*)

L. B. TUCKERMAN, National Bureau of Standards: *What hardness is or what hardness is not.*—Much effort has been expended in an attempt to give an all inclusive definition of "hardness" which would receive universal scientific and technical acceptance. Frequently such phrases as "true hardness," "absolute hardness," "real hearness," etc., appear in the literature. Even as keen a thinker as Heinrich Herz could say "Now as I went on working it became clear to me what hardness really was."

All attempts to formulate a definition of an inclusive concept which would cover all the current technical implications of hardness and thus warrant the designation of "true" or "absolute" or "real" hardness, have so far failed, and in the nature of the case must fail. "Hardness" in common parlance and even in technical usage represents a hazily conceived conglomeration or aggregate or properties of a material more or less related to each other.

A study of the very diverse properties included under the one term "hardness" shows that they are all in their essence negative properties. A material is called hard if it is not easily scratched; is not easily worn down; is not easily deformed, either elastically or plastically; is not easily broken; is not easily melted; is not easily demagnetized; etc. etc. All that is common to these properties is that the physical state of the material is not easily changed in one or more particulars by outside mechanical, thermal or other physical influences.

A better understanding of their diversity is obtained by thinking rather of the different implications of softness, i.e., of the different ways in which the physical state of a material may be changed, rather than of their negation "hardness."

The softness of a feather pillow is obviously something wholly different from the softness of putty. The softness of annealed steel is different from either, and the softness of soft glass is something different from any of these.

Not only may the "softness" of different materials represent wholly different kinds of behavior, but even the same material may exhibit different kinds of softness. The softness of a piece of copper in plastic yielding under load is something entirely different from its softness when scratched or abraded.

This is easily shown by comparison of a copper alloy with an annealed mild steel. Pairs of such materials may easily be found in which the steel scratches the copper but the copper indents the steel. In such a case there is no answer to the question, "Which is the harder of the two?" unless the whole complex of procedure involved in the determination of the particular "not softness" is specified in detail. (This was illustrated by numerous experiments with a wide variety of materials.)

The fact that it is impossible to formulate any acceptable definition of hardness to include all the current implications, in no way lessens the practical value of the common indentation and scratch tests. They are among the most useful tests in the control of the uniformity of a product. (*Author's Abstract.*)

These papers were discussed by Messrs. WENNER, MCNISH, HAWKESWORTH and MCCOMB.

H. H. HOWE presented an informal communication on *Errors in the theoretical determination of the velocity of light.* This was discussed by Mr. BUCKINGHAM.

1121ST MEETING

The 1121st meeting was held in the Cosmos Club Auditorium, May 22, 1937, President WENNER presiding.

Program: F. C. BRECKENRIDGE and W. R. SCHAUB, National Bureau of Standards: *An orthogonal color coordinate system having uniform chromaticity scales.*—The advantages and limitations of the I. C. I. coordinate system (See J. OPTICAL SOC. AM. **23**: 359. 1933.) and the trilinear coordinate system yielding uniform chromaticity scales as proposed by Judd (See J. OPTICAL SOC. AM. **25**: 24. 1935.) were compared. The advantages for engineering applications of a system combining the rectangular coordinates with the uniform chromaticity scale (UCS) was pointed out. The UCS triangle has been transformed to give such a system. A slight modification of the constants and a simple translation gives a system of coordinates in which the first quadrant contains only greens, the second reds and yellows, the third purples and the fourth blues. A diagram containing small areas illuminated with the appropriate colors was exhibited. (*Author's Abstract.*)

WILLIAM F. FRIEDMAN, Signal Reserve: *Cryptography.*—Beginning with a brief history of cryptography, including examples of the use of cryptography in Biblical and ancient times, the speaker illustrated the various types of codes and ciphers employed by the Federal Army and the Confederate Army in the Civil War, and by the various belligerents in the World War, 1914–18. These examples included instances of the employment of sympathetic or invisible inks, code books, cipher systems, and cipher devices, the last named opening the way for a discussion of modern cryptographic machinery constructed for the purpose of facilitating the enciphering and deciphering of messages with great rapidity and with a high degree of cryptographic security. The speaker concluded this part of his paper with the comment that the development of such machinery was today engaging the attention of many large governments and that the hope of reaching a satisfactory solution would no doubt be fulfilled. Question was raised as to the possibility of devising a system which could be regarded as being absolutely indecipherable. The speaker stated that while theoretically such a system is possible, despite the famous dictum established by Poe to the contrary, the actual embodiment of this theoretical possibility in a practical machine

or system remains yet to be accomplished. The speaker then directed attention to one of the interesting side lights of his subject, namely, the attempts on the part of various persons to prove, by means of cryptography, that the authorship of certain works, principally those of Shakespeare, is spurious and that these works should be credited to others. (*Author's Abstract.*)

The first paper was discussed by Messrs. TUCKERMAN, HAWKESWORTH, WENNER, HUMPHREYS, BROMBACHER and DRYDEN.

An informal communication on *Radio fade outs* was presented by A. G. MCNISH.

H. S. MCCOMB, *Recording Secretary.*